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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Paper Profits

When replying to a vote of thanks accorded by the Scottish Branch of the Institute of British Foundrymen for the presentation of his Paper on "Melting Practice in a Large Engineering Iron Foundry," Mr. W. W. Braidwood, the author, referred to the personal benefit he had derived from the task of its preparation, and he advised other young men to seize any such opportunity as he had had. The undoubted success that this Paper has achieved is due to its circumscription. Only too often do lecturers essay to cover too wide a field. It is admitted that, by so doing, one can interest a larger local public as auditors, but in the last analysis a Paper thoroughly covering one phase of foundry technique commands the attention of everybody concerned with the subject from a national standpoint. It so happens that the melting plant described is particularly well laid out and efficiently operated, but that is really incidental, for any honest description of what one does and the results obtained is equally of value, as it allows comparisons to be made. Moreover, every plant or process has its strong and weak points, and by analysis and the application of the appropriate phases the general level of technique is thereby raised.

In cupola melting practice there is a constant striving to marry mechanical and metallurgical efficiency. We are familiar with some really old-fashioned plants which are so operated that they produce excellent metal of controlled composition, whilst others which are well served from a mechanical point of view are not too good when the quality of metal is considered. Attention to the weighing of the charges is worth while, and the use of a system which allows a full charge to be built up in one receptacle by adding successively the various ingredients, each increment being noted by a higher reading on the same scale, eliminates inaccuracies due to a multitude of "trets." These inaccuracies are capable of revealing at stocktaking time a wide divergence between materials bought and those used. It is by the citation of such small yet important details as weighing which stresses the value of a Paper on a circumscribed subject. The ideal bin for the storage of raw materials for melting furnaces has yet to be designed. Steel plates buckle, concrete "flies," brick walls tumble, wood splinters, and cast iron breaks, so the only solution appears to be armour plate! Readers' views on this small subject would be welcome.

It should not be thought that there is no room for Papers of wide scope, for the reverse is the truth. Such contributions widen one's viewpoint. The review which Mr. MacColl has given of "Alloy Cast Iron" has served the purpose of exposing the entire field wherein researches have been made. Only too often, because a foundry manager has achieved success with a certain combination of alloys for a given purpose, he is inclined to rest upon his laurels, imagining that he has reached finality. When, in 1900, high-speed steel was exploited commercially for the first time in history, many metallurgists thought that reached something approaching finality. Yet a few years later, owing to the discovery that a vanadium addition made a fivefold improvement, all the trade names for high-speed steels were hyphenated to carry the word "superior" or some similar term. Since that time there has been the introduction of cobalt, and now there is the tungsten-carbide variety of cutting tool. We esteem alloy cast iron to be in the same position as was high-speed steel in the period 1900-1905, and we anticipate developments of a like character. Germany apparently has decided that the major field for cast iron is the unalloyed variety, special attention being directed towards getting the best out of the five basic elements. Whilst this is very laudable, the main consideration, we suspect, is that of national economy. No doubt we shall hear at the International Foundry Congress of the progress registered; at any rate, a contribution giving the optimum properties of plain unalloyed cast iron would be refreshing. It would enable the foundrymen to evaluate the real worth of alloy additions and their cost. The situation has been more or less resolved by the proprietors of one of the best-known processes for the improvement of cast iron, as in their high-duty mixtures they do not hesitate to add alloys.

The benefits to be derived from Papers which invite the discussion upon detail and those which open up a wide vista for future progress are very real. The former are of the type which can be assessed as gilt-edged investment, whilst the latter must be regarded as a sound speculation.

Notes from the Branches

Wales and Monmouth Branch.—A party of members of the Wales and Monmouth Branch of the Institute of British Foundrymen visited the works of the Westinghouse Brake & Signal Company, Limited, at Chippenham, on March 16. The South Wales party met West of England members at Bristol, then travelling by motor-coaches to the works, where they were received by Mr. Potts, Mr. Gordon and Mr. Hodgson. Dividing into two parties, the visitors were conducted around the works by guides.

At the conclusion of the tour tea was provided, after which a hearty vote of thanks to the company was proposed by Mr. A. V. Biggs (President of the Bristol section). This was seconded by Mr. R. G. Williams (retiring President of the South Wales Branch). Mr. Cruse, the works manager, in replying to the vote of thanks, expressed the pleasure of his firm in having the visitors at the works, adding that a second visit, if desired, would willingly be arranged.

Bristol Section.—The Bristol Section of the Institute of British Foundrymen held the annual meeting at the Merchant Venturers' College, Bristol, on March 18. Mr. M. Wayman was elected President and Mr. F. G. Jackson Vice-President, while Mr. Hares was re-elected to the office of Hon. Secretary. A vote of thanks to the retiring officers was proposed by Mr. J. J. McClelland and carried unanimously. At the close of the annual general meeting a Paper was read by Mr. J. F. Gist, of Pontypridd, on "Some Factors in the Production of Electric Steel Castings."

New Contracts for Warships

The Admiralty announce that, subject to the settlement of certain points, they have decided to place orders as shown for the following vessels of the 1939 programme:—

One Minelayer.—R. & W. Hawthorn, Leslie & Company, Limited, Hebburn-on-Tyne.

Two Escort Vessels.—John Brown & Company, Limited, Clydebank.

Two Escort Vessels.—Cammell Laird & Company, Limited, Birkenhead.

Two Escort Vessels.—Parsons Marine Steam Turbine Company, Limited, Wallsend-on-Tyne (hulls by Vickers-Armstrongs, Limited, Newcastle-upon-Tyne).

Two Escort Vessels.—Swan, Hunter & Wigham Richardson, Limited, Wallsend-on-Tyne (machinery by Wallsend Slipway & Engineering Company, Limited).

Two Escort Vessels.—Yarrow & Company, Limited, Scotstoun.

The 1939 programme includes 20 fast escort vessels of a new type. These first orders under the programme have been placed much earlier than is usual.

Application for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"LODED CENTRICAST."—Castings. Sheepbridge Stokes Centrifugal Castings Company, Limited, Chesterfield.

Ironfounding Workers' Association

The Ironfounding Workers' Association, which represents most of the employees in the light castings industry in Scotland, will celebrate its jubilee at a social gathering in Falkirk on Saturday this week. The union was originally known as the Scottish Central Ironmoulders' Association, and was started in Falkirk with a membership of 742. There are 72 of the original members alive, and they are to be entertained at the jubilee function.

American Notes

Ball Joint Castings

The Mobile (Alabama) Pulley & Machine Works has recently produced ball joint castings in sizes ranging from 8 to 30 in. dia. and 100 to 4,800 lbs. in weight, for use in dredge lines on suction dredges operated by U.S. Army engineers. The foundry produced several hundred tons of these parts, all made of nickel-chromium steel to strict specifications. The cast steel had to give a tensile strength of over 45 tons per sq. in., and to pass a 90 deg. cold-bend test around a 1 in. diameter bar. It was made from a 0.45 C, 2.0 Ni and 1.0 per cent. Cr steel.

* * *

Milk Core Binder

In a recent patent awarded to Harold K. Salzberg, of Pittsburgh, by the U.S. Patent Office in Washington, the use of milk is advocated for the preparation of metal castings of greater accuracy and smoothness. The patent states that milk contains both lactose and casein. When the casein has been solubilised, it is claimed, the milk produces an excellent binder for forming sand moulds and cores. The inventor claims the casein-solubilised milk acts like a glue, holding the sand particles and producing a smooth, non-sticky, hard mould of exceptionally high strength. The milk and sand are mixed in proportions of 1 per cent. of the former to 99 per cent. of the latter. The solubilisation of the casein is achieved by treating it with different chemicals, such as oxalates, fluorides or metaphosphate. The inventor has assigned his patent to the Borden Company of New York City.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Mixtures for Silicon-Carbide Production

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—According to your report on page 228 of last week's issue, Mr. Bromage, in reply to a question by Mr. Longden, gave the proportion of carbon to sand as 70 per cent. of sand to 38 per cent. of carbon. Whilst I am quite ignorant of the practical details, I should have thought, on theoretical grounds, that the proportion would be 80 per cent. of sand and 20 per cent. of carbon. In any case, where the two percentages make more than 100 per cent., it is difficult to realise just what is meant. The Paper and discussion I found very interesting.—Yours, etc.,

"YOREDALE."

(*Continued from next column.*)

"Come this way," said the porter to the agitated lady who had arrived late for the train. "I'll fix you up at the front of the train." "You'll do no such thing," the lady replied indignantly; "I'm no mascot."

* * *

Lot III from the Barrington Hooper Collection.

Sign on the wall of a seaside dance-hall: "The management reserve to themselves the right to expel anybody they think proper."

* * *

The husband was reading out of the newspaper.

"I see by the paper that out of every hundred persons fined for travelling without a ticket, seventy-five are women."

"There," exclaimed his better half. "That only goes to show that women are more economical than men."

"MARKSMAN."

Random Shots

Requests "to view" the solution to the monkey puzzle continue to arrive from problem-tacklers, who complain that they have not had a good night's rest since its publication!

* * *

According to one reader, the answer to "What is one three-quarters of ?" is not far from 1¾. No doubt someone with a mania for greater accuracy is still working it out, and will let the world know next week the *exact* answer, correct to ten decimal points.

* * *

The same enthusiast sets another problem, in which he asks, "Do you know what is the moment of inertia? No; well, I'll tell you. When you throw a ball up in the air, it slows down until, just before it commences to return, it is stationary for an instant. That is the moment of inertia. At any rate, my son says so. Can you imagine what will happen to him at his moment of bending?"

* * *

At a time when intending participants in the forthcoming International Congress in London are thinking of filling in the various forms of that familiar travel agency, Thomas Cook, it is of special interest to note that next year marks the centenary of that firm. The first tour ever organised by the original Thomas Cook was an excursion train run from Leicester to Loughborough in 1840, a distance of 22 miles, for one shilling. The occasion was, so "Marksman" believes, the annual outing of a local Sunday School or some such church organisation.

* * *

This Thomas Cook, founder of the present firm, was born at Market Harborough, a quaint old-world town near Leicester. During the Post-Conference Tour, which includes a visit to Leicester, it would make a charming and delightful pilgrimage to visit Market Harborough, for it also has the distinction of possessing a little grammar school, famous both for being erected on stilts over the butter market, and for being the school in which Sir William Bragg received some of his early education. Sir William Bragg's brilliant son, it will be remembered, is giving the Edward Williams lecture at this year's Congress. And should the travellers feel in need of refreshment, either liquid or solid, they should not miss an opportunity of visiting the ancient hostelry of the "Three Swans," whose landlord is an innkeeper of some fame, John Fothergill. The diaries of his experiences as an innkeeper would, by the way, make very interesting reading over Easter.

* * *

The Editor tells a good tale. He was walking past the stage door of the Opera House on his way home from the office the other night. Propped up against the door was a huge wooden axe, part of the emblem of the French Republic to be erected in the Opera House in honour of M. Lebrun on the occasion of the Royal Gala performance the following evening. Just as he was passing, his heart heavy with the forebodings of the recent turn in international events, a small group of workmen emerged from the fruit warehouse opposite. Spying the wooden but bellicose-looking axe, one of them called out in his cheery Cockney voice, "Lumme, they've come!"

* * *

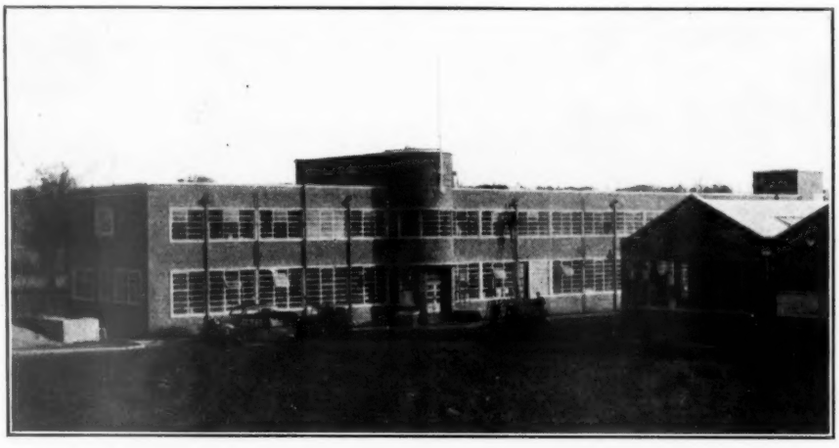
"Marksman's" tip for the Cup Final.—It will undoubtedly be between Portsmouth and Grimsby (owing to the geographical situation of Wembley).

(*Continued in previous column.*)

New Works of the Cwmbran Engineering Company, Limited

SAUNDERS VALVE SUBSIDIARY

The Saunders valve was the invention of Mr. P. K. Saunders whilst he was engaged upon research work on compressed air for a group of gold mines in South Africa in 1926; some three years later he came to England and endeavoured to place the valve on the market, but met with little encouragement; he therefore took his invention to America, where its manufacture was immediately taken up on a royalty basis.



View of the Offices from the Main Entrance.

In 1933 Mr. Saunders returned to this country and formed the Saunders Valve Company, Limited, with offices and a small works at Wolverhampton; it was a very modest beginning, the works being nothing more than an assembly shop of the parts which were factored. It, however, required but a very short time for the Saunders valve to prove itself under working conditions, and a considerable business was speedily built up. The company next put down a machine shop, and did a considerable proportion of their own work; however, almost before the additions to plant and works were completed, demands for valves had exceeded the possibilities of the works.

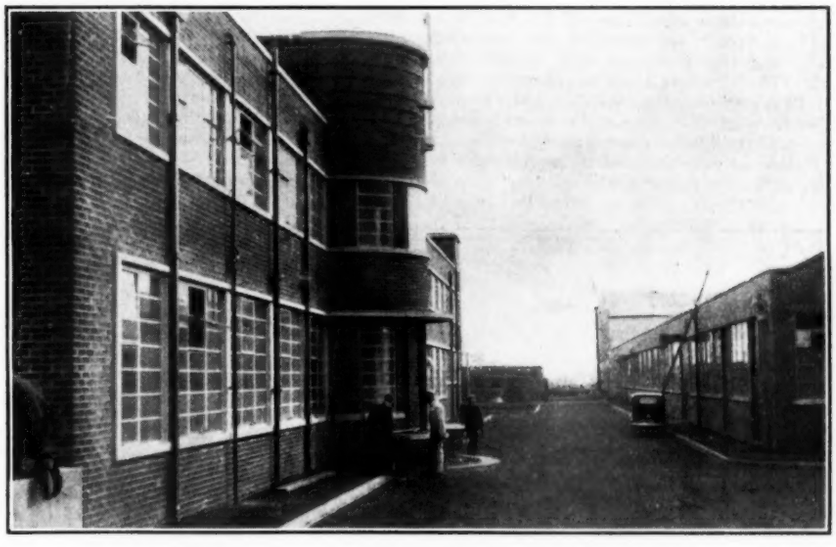
The site of the existing shops afforded little room for extension, and further, the directors recognised there would be considerable advantages in building an entirely new works, in which the experience they had gained in the existing works could be turned to profitable account. There was perhaps more than a spice of sentiment in the selection of Cwmbran as the site for the new works. Industrially it was one of the black spots in Monmouthshire, and the directors of the Saunders Valve Company, Limited, felt that the establishment of a new industry in the district would afford some relief.

Some 8 acres of land were acquired on the Grange Road, Cwmbran. The works are set back from the road, and the offices, which face the entrance, are approached by a broad macadamised road finished with a footpath and flanked on either side by ground which is being laid out as lawns, tennis courts, etc. The whole of the works are surrounded by tarmac roads and footpaths. The works are very conveniently situated and will have excellent transport facilities, as one side of the site is bounded by the main lines of the Great Western Railway, to which the works sidings will be joined up.

The general offices form an imposing block of buildings, the offices themselves being on either side of a central aisle, so that the fullest possible advantage is taken of natural lighting. There is a well-appointed canteen and staff dining rooms.

THE WORKS

It was very wisely determined to render the works, so far as practical, self-contained, and to this end a foundry and rubber shop have been incorporated. Pride of place must undoubtedly be given to the foundry, which is one of the best in layout and equipment for the mass production of small parts. It was, of course, desirable to cast the body of the valves with such accuracy that no machining was necessary, and hitherto considerable difficulty had been experienced in obtaining castings of this nature. It was also deemed advisable to make castings with location V's in them to ensure correct location of the parts in the jigs and fixtures in the machine shop, which again called for accurate work. It is therefore obvious that very close inspection is necessary, and before leaving the fettling shop, all castings are carefully gauged and then passed to the unfinished castings storage racks. The arrangements appear to be working very well, though a few minor alterations are still being made on some of the pattern plates.



Entrance to Offices (left) and Part of Works (right).

As there are so many small parts to handle, a system had to be evolved to move them through the various shops, assembly bay and finally to the packing room. This difficulty has been met by the provision of a number of racks and trays which are handled by means of "hand lift" trucks. The trays hold from 35 to 40 lbs. of castings and a fully-loaded rack weighs about 15 cwts. It will be understood that the castings are first loaded up on to trays after leaving the shot-blast chamber or shot-blast tumbling barrel, as the case may be. The method is a very economic form of handling, as the castings storage racks also accommodate the trays.

Sand-Handling

One of the chief problems in the foundry was that of sand-handling. It must be remembered that valve parts are very miscellaneous, both as regards configuration and weight, varying in the last respect from a few ounces to several hundred pounds, and in addition a proportion of the smaller valves may be specified in various non-ferrous metals. It was therefore of primary importance to find a sand that would be universal in its nature and capable of being used for both hand- and machine-moulding. It had also to be such as to form the main constituent of the core-sand mixture so as not to build up the amount of sand in the sand system with consequent loss due to having to discard it.

Natural moulding sands could not comply with such conditions and a synthetic sand is used, which up to the present has proved satisfactory. The sand is regularly tested in the laboratory on Fischer testing equipment and the ingredients varied as may be found necessary to ensure as constant a product as possible. The present sand is made up from Leighton Buzzard No. 26 A silica mixed with 6 per cent. of "Colbond" and 3 per cent. coal dust. The mixture is kept up to strength by daily additions of "Colbond," the coal dust being added at the discretion of the foundry foreman. Moisture is held at from 4 to 5 per cent., preferably the lower, and a bond strength of about 6 with a permeability of 125 to 150 is aimed at.

For cores, the synthetic sand is mixed in the ratio of 60 per cent. to 40 per cent. sea sand with proportions of "Permol" and "Glyso" to suit the particular batch of cores being made.

D

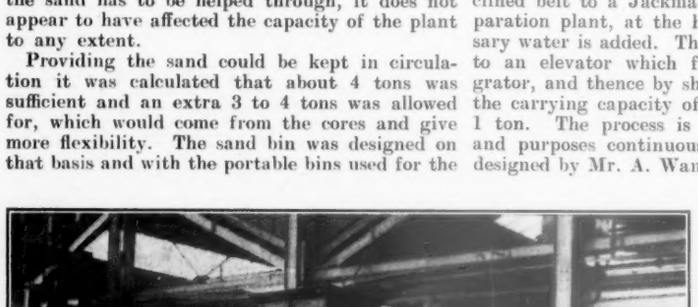
The mixture gives very satisfactory cores. All the small cores are made on core-blowing machines, the larger sizes being hand-made, but using much the same mixture. The moulds are knocked out over a grizzley with bars spaced ¾ in. apart. This spacing may appear unduly narrow, but it was the maximum possible owing to the small sizes of many of the castings. Whilst the sand has to be helped through, it does not appear to have affected the capacity of the plant to any extent.

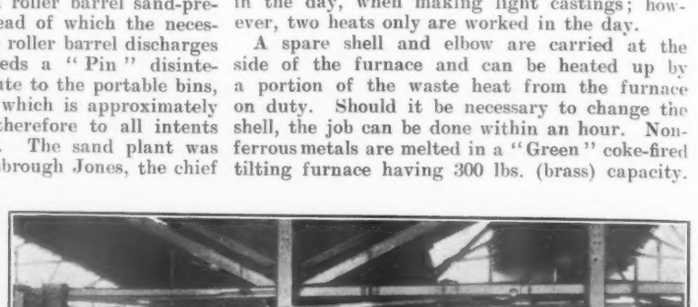
Providing the sand could be kept in circulation it was calculated that about 4 tons was sufficient and an extra 3 to 4 tons was allowed for, which would come from the cores and give more flexibility. The sand bin was designed on that basis and with the portable bins used for the moulding machines, a leeway of a further 4 to 5 tons is given. The necessary additions of "Colbond" and coal dust are added at the knock-out.

From the knock-out hopper the sand is delivered by belt conveyor to the boot of a bucket elevator, which discharges on to a further short belt which feeds the material over a drum-type magnetic separator and thence the sand falls on to a double-deck "Niagara" screen with ½-in. mesh on the top deck and ¼-in. mesh on the second. The through material from the lower deck falls direct into the sand bin. The oversize from both decks is delivered to a small double Muller sand mill, the discharge from the mill being delivered into the boot of the elevator for recirculation over the screens.

At the end of run and repeated trips through the mill anything that comes over the screen can be collected and discarded as waste. It is rather a mystery where the waste comes from, as it is largely foreign matter, and great care is exercised to keep the sand clean all through the plant.

From the sand bin the sand is fed by an inclined belt to a Jackman roller barrel sand-preparation plant, at the head of which the necessary water is added. The roller barrel discharges to an elevator which feeds a "Pin" disintegrator, and thence by shute to the portable bins, the carrying capacity of which is approximately 1 ton. The process is therefore to all intents and purposes continuous. The sand plant was designed by Mr. A. Wansbrough Jones, the chief engineer of the company, and was built by the Phœnix Supply Company, Limited.





Views of Melting and Annealing Furnaces and Vertical Boiler.

The Melting Plant

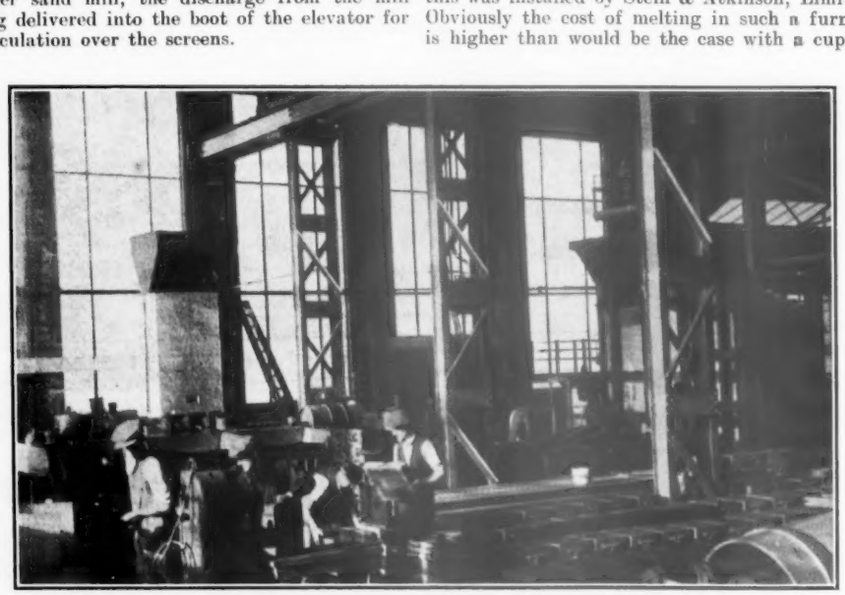
The question of the melting unit called for a considerable amount of thought, as a ton of metal goes a long way in small valves and the storage of moulds becomes quite a problem of its own, if more than a ton of metal is ready to pour at once. Actually some 200 moulds have been filled to the ton of metal.

It was decided that a 1-ton rotary oil-fired furnace would best meet all requirements, and this was installed by Stein & Atkinson, Limited. Obviously the cost of melting in such a furnace is higher than would be the case with a cupola, but such extra cost is negligible when spread over a ton of castings, while the rotary furnace has the advantage that either grey iron or malleable can be cast the same day, or special irons if needed at short notice. The flexibility thus more than offsets any question of cost, and, further, the furnace is more easily handled with unskilled labour. Four heats are easily possible in the day, when making light castings; however, two heats only are worked in the day.

A spare shell and elbow are carried at the side of the furnace and can be heated up by a portion of the waste heat from the furnace on duty. Should it be necessary to change the shell, the job can be done within an hour. Non-ferrous metals are melted in a "Green" coke-fired tilting furnace having 300 lbs. (brass) capacity. This furnace is more than capable of taking care of the incidental output of non-ferrous castings.

Annealing of the malleable castings is carried out in a Stein and Atkinson producer-gas-fired furnace, about three charges in two weeks being the maximum capacity. Temperature control is by means of an Electroflo pyrometer and chart which is checked by means of Seger cones. A rather interesting use for the Seger cone was developed, namely, setting up a range of them in a tube placed in the centre of the pot in order to check how long it took for the heat to penetrate through to the centre; this, of course, was only practised during the early stages when the furnace started up.

Adjacent to the melting furnace and the annealing furnace is the vertical boiler which supplies steam for shop requirements and for the producer. The waste heat from the melting and annealing furnaces is utilised under the boiler and is supplemented by fuel fed by a Robot stoker supplied by the Riley Stoker Company, Limited.



Moulding Machines and Mould-Storage Tracks.

Moulding and Handling of Moulds

It was obvious that when considering the design and layout of the foundry, a sharp line had to be drawn between what castings were to be mass-produced and what could be handled by slower methods. After many computations based on weights, output, and configurations, it was decided to make all parts for valves up to and including 3 in. on the former basis, though some few parts of the larger valves have since been added. Further checks showed that a 16-in. by 14-in. pattern plate and moulding box would accommodate all such parts in the required numbers and this was made the standard for the foundry. Boxes for use with such a plate were cast in the foundry in depths of 4 in., 6 in., and 8 in. The 12-in. depth for a few odd castings is obtained by bolting two of the 6-in. boxes together.

The moulding machine finally decided on was the Tabor type, jolt, squeeze and draw, built by Macnab, Limited, the pattern plates being heated by means of a gas ring under the plate. This is essential on practically all the patterns. Three of these machines are installed; two working together making drags and copes of the same pattern. The third machine is assumed to be a spare, but it is actually being used for miscellaneous parts that are constantly being called for and also for making samples from new plates for checking purposes.

Reference has already been made to the manufacture of cores. Of the two core-blowing machines, one is a Coleman R.3 and the second a 45-lb. capacity "Titan" by Constructional Engineering Company, Limited. The small cores are loaded on to perforated carriers and charged into one of the six cabinets which are heated by coke-fired hot-air producers. The large cores are handled on shelf racks and loaded into one of the two 6-ft. by 6-ft. by 6-ft. ovens which are heated in a similar manner to the small core stoves. The waste heat from the last, however, is used for drying the new sand, a method which has met adequately all requirements. Both sets of core ovens were built by the Phœnix Supply Company, Limited.

An Osborn roll-over jolt moulding machine which will take pattern plates up to 24 in. by 24 in. takes care of the larger moulds. These are delivered from the machine by an inclined roller gravity track to a floor adjacent to the melting furnace. If too heavy, they are closed by the aid of the foundry crane and are poured when there are sufficient to warrant a heat.

For the small mass-produced castings, the mould storage between the heats is provided for by roller racks and steel-plate benches set 9 in. from floor level; this, with the addition of the height of the bottom boards and boxes, is found to give a convenient height for pouring. There are four rows of roller track each 35 ft. in length, which provides ample storage space. The moulds are cored on a table adjacent to the moulding machine, and pouring basins and risers are also cut at this point. Moulds are not closed until they are in their final location on the storage benches. The metal is poured from double-shank ladles handled by a man on each side of the storage bench. Running at right angles to the end of the storage tracks is a roller conveyor which serves to deliver the moulds to the knock-out, the portion of the track which blocks the pouring alley being easily removable and only reinserted when required.

In the fettling shop there is a shot-blast chamber and a shot-blast tumbling barrel, both by the Phœnix Supply Company, Limited, and finally there are the inspection benches where all work is checked and gauged before being passed into the unfinished castings stores.

Machine Shop

Every operation in the machine shop is done to jigs, and it will be readily understood that most of the machine tools are of a special nature. In order to carry mass production to its logical conclusion, machining operations must be reduced to a minimum, but they must also be mathematically accurate. So far as practicable, the work in the machine shop is sectionalised, one side of the shop dealing with the large and the opposite side with the smaller valves.

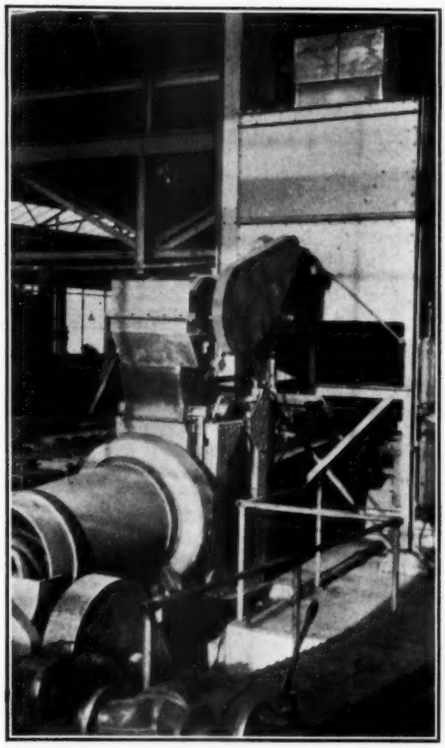
Of the machines installed, mention may be made of two machines upon which both sides of the valve body are faced, drilled and tapped at one operation. A special drilling machine which simultaneously drills four holes in the bonnet, drills and faces the central hole for the bush which carries the spindle. For valves up to 2 in. the finger plate which supports the diaphragm is welded on; above 2 in. it is cast with the bonnet. There is a special horizontal milling machine for facing the flanges of the heavier valves. Other machines include radial drills, capstan lathes, etc.

The compressors for the supply of the pneumatic tools, etc., are installed at one end of the shop. They comprise two Ingersoll Rand machines, one of 340 cub. ft. capacity at 40 lbs. pressure and one of 150 cub. ft. at 150 lbs.; both machines are driven through Vee ropes from a single motor.

At the top end of the machine shop is the assembly department. Here again separate benches are allocated to large and to small valves. Benches are also laid off for the inspection and gauging of finished parts. It may be noted that it is not the practice to carry any stocks of complete valves; every standard size can be readily assembled from stock. After assembly, all valves are tested up to 100 lbs. pressure.

Rubber Shop

The rubber shop houses the usual rolls for breaking down and compounding, and a press



Sand-Preparation Plant.

for cutting to shape for the moulding of diaphragms, together with nine small, one medium and one large moulding presses, which are steam heated. Hydraulic power for the presses is supplied by a pump and accumulator. A vulcanising chamber is also in service for vulcanising where the valves are specified as "rubber lined."

The pattern and wood-working shop is very well laid out and equipped with a range of the usual up-to-date machines. A remarkably well-equipped laboratory is situate immediately at the entrance to the works. All raw material is subject to analysis, and a complete control is maintained over all operations in the foundry and the works, whilst a considerable amount of research work is carried out, particularly in regard to rubber and sands. The laboratory equipment includes tensile-testing machines for both metal and rubber.

There is a works canteen, clothes locker rooms and excellent lavatory accommodation. The washing facilities are rather unusual, comprising a number of large circular bowls around which jets of hot water are delivered from a central main, the effect being that a number of men can wash simultaneously in clean water, the water delivered into the bowl running to waste.

The whole works are covered by one roof, comprising two bays, each about 38 ft. wide and approximately 500 ft. in length; the building is in red brick, roofed with asbestos corrugated sheets, the side walls being really little more than supporting columns for the roof and glass sides. The floor is laid with concrete, and the whole of the necessary mains, water, steam, condensate, hydraulic and compressed air are carried immediately below the eaves, and each is painted a distinctive colour, and thus is readily identified.

It is hoped to get the works on full production during the coming summer; in the meantime the whole of the light and medium valves are being made at Cwmbran, the Wolverhampton works being retained to deal with the large valves, until Cwmbran can take over.

It is worthy of note that the whole of the work of preparing the plans, arranging the lay-out and equipment of the works was carried out by Mr. Jones, who is deserving of congratulation. The processes of manufacture have been welded into a harmonious whole; nothing is wanting which would conduce to efficiency on the one hand, or lead to economy on the other; neither is there any unit of plant extraneous to actual requirements. The foundry in particular is an excellent example of a modern lay-out for mass production on economic lines with the simplest possible form of mechanisation.

Alderman Arthur Jenkins, M.P. for Pontypool, declared the works open on March 15. Prior to the opening ceremony, the visitors numbering about 300, after making a tour of the works, were entertained at luncheon in the canteen by the directors of the Saunders Valve Company, Limited.

Catalogues Received

Moulding. Bulletin No. 801, issued by the Foundry Plant & Machinery, Limited, of 113, West Regent Street, Glasgow, describes and illustrates the swing type of Sandslinger. This machine has been developed for the quantity-production of small moulds and cores. The design is such that the impeller-head swings in any direction for the actual ramming operation. The machine takes the form of a ramming head connected to a motor, with a hopper at the top of the head and a spout for directing the sand into the box beneath the head. The pivotal arrangement allows for the end of the machine to be moved about so that the stream of sand can be directed into any pockets or small openings in the pattern or into small core boxes. This new type of Sandslinger is made with a 19-in. ramming head to operate at 1,200 r.p.m. This delivers up to 20 cub. ft. of sand per min., varying of course with the type of work undertaken. Naturally such a machine requires ancillary plant to achieve the most economic results, and several schemes are indicated for this purpose.

Fans. Two catalogues have reached us from Aerex Fans (Branch of Colliery Engineering, Limited), of 46, Rutland Park, Sheffield, 10. They are numbered 306 and 405, and the former devotes much of its space to details of manufacture and assembly of the fans, which are of the screw type. The second one details the claims for the fans and gives a series of line drawings showing practical applications. A typical case given is that of exhausting the fumes from a battery of vitreous-enamelling booths. Later illustrations of actual installations are given, but beyond the one cited no foundry applications are depicted. These catalogues, which are very nicely got up, are available to our readers on application to Sheffield.

A New Steelmaking Process

AN IMPORTANT DEVELOPMENT AT CREWE

By VINCENT C. FAULKNER

Several years ago the writer witnessed what he believes was the first large-scale attempt to manufacture steel in a rotary furnace fired by pulverised fuel. This was at the Mons Steel Foundry in Belgium. At that time his views could be embodied in the statement that the process showed the greatest potential value as a cheap and efficient method of making steel, but he doubted whether the process lent itself to any great measure of refining. The latter half of this statement he based on the difficulty of watching the operations in the bath; he anticipated trouble in carbon control, and therefore in control of some other elements. The favourable prospects were ascribed to the low cost of operation.

About this time, a firm in the North of England from time to time made heats of steel, but it goes to the credit of the executive staff of the London Midland & Scottish Railway that they have pioneered the process right through to achieve a really sound technical and commercial success.

Plant Details

The plant which has been installed at Crewe consists of two 5-ton capacity Sesci furnaces. It is not proposed in this article to give a detailed description of the plant, as it is now well known in foundry circles. It is, however, germane to recall its salient features. The furnace is characterised by the fact that it utilises pulverised anthracite after the recuperators—which are an essential part of the system—have reached a predetermined temperature as shown by the temperature of the air used for combustion. In commencing the first heat of the day, bituminous coal only is fed into the pipe line, but when the preheated air reaches about 100 deg. C., a small proportion of anthracite is introduced, the bituminous coal being reduced by a similar amount. The process of increasing the anthracite whilst reducing the bituminous coal is continued until the state is reached when anthracite only is used, the indicator for the preheated air showing a temperature of about 250 deg. C. The rotating speed of the furnace body is of the order of one complete revolution per minute. The body is provided with two tapholes centrally situated, and it is interesting to state that no serious trouble has been experienced with their manipulation. As is the case with all plants of this type, a spare body for each furnace has been provided, but from what follows it can be gathered that one for two or more furnaces should suffice in the future.

The furnaces are machine-charged by exactly the same system familiar to every visitor to a modern open-hearth plant. That is, long steel plate boxes are provided at one end with a rectangular slot into which fits a key attached to the arm of the machine and racking in for removal of the box. The nature of the charge at Crewe is such that the whole of it can be put in initially, as only 9 cwts. of turnings are used.

The fuel is pulverised by a Tollemache plant, the fineness for the bituminous being 85 per cent. through a 200-mesh B.S. sieve and for the anthracite 99.3 per cent. to pass a 120-mesh B.S. sieve. The burner is of the standard Sesci type, and this has created no difficulties since the plant was put into commission in July, 1935.

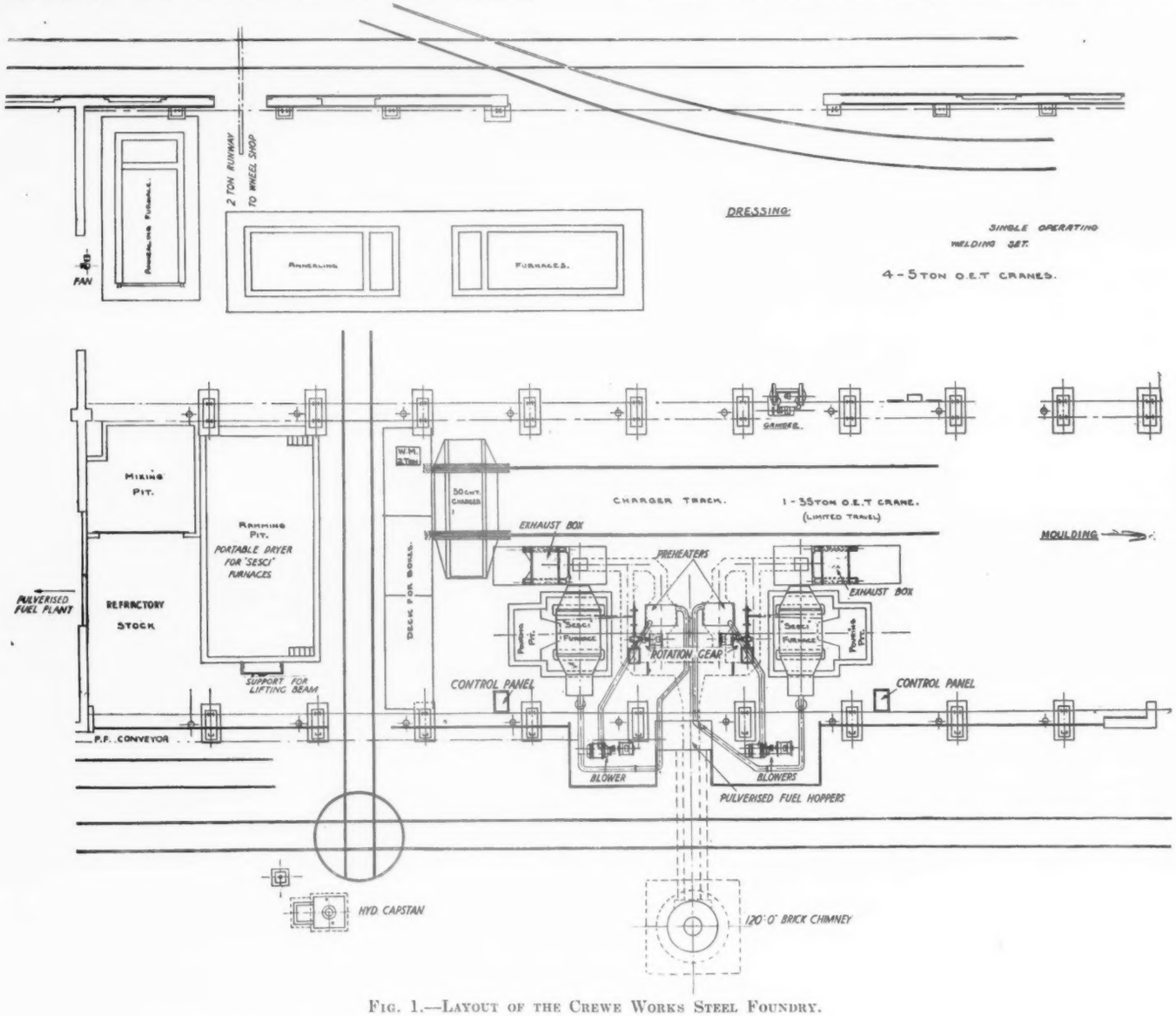


FIG. 1.—LAYOUT OF THE CREWE WORKS STEEL FOUNDRY.

The cast-iron grids, however, gave trouble at the start, but this has been overcome.

Preparation of the Lining

Most operators have reached the conclusion that it is essential that the lining of a rotary furnace be prepared initially by ramming in the refractory whilst the body of the furnace is in the vertical position. By so doing the expansion can be countered to a large extent by instituting an even density of ramming. The preparation of the refractory calls for a good deal of experience, and a rigid control is imposed to ensure that a consistency of 7.5 per cent. moisture is established uniformly throughout the mass before ramming is started. The drying and heating is a lengthy business, and too much care cannot be bestowed upon its conduct. Lapses from standard will materially impair the life of the lining. Up to now a refractory of French origin has been largely used, but it is interesting to note that one of the barrels at present in operation is lined with a British material which is giving very promising results.

Fig. 2.—General Appearance of the Melting Plant.

Operating Details

For the operation of the two furnaces there is a staff of four men—a melter with an assistant and two charge-wheelers for preparing the charge. A heat generally takes under four hours, but very occasionally a longer time is taken for reasons which are the subject of current investigation. It may be traceable to either a heavier slag or to some departure from standard in the grinding of the fuel. However, these longer heats would not materially affect the average time per heat when spread over a long period.

A problem still unresolved is wear of the refractory lining in one of the exhaust boxes. Here are two identical furnaces, working to similar schedules, yet in one case the refractory stands up quite satisfactorily to the conditions imposed, whilst that of the second furnace continues to be a source of minor trouble! Furnace operation will ever be as much an art as a science.

The charge is worked down as in most steel-making processes. Here a wide field immediately presents itself, involving the potentialities of flame conditions, the working down of high-carbon charges so as to make use of exothermic reactions, and so forth. The carbon reduction is something of the order of 0.15 per cent., usually accomplished without any iron-ore additions. This system, whilst not making any great use of exothermic reaction, does help to ensure a cleaner steel. That this is being achieved is well shown by the high impact test results recorded. An Izod impact value of 35 to 40 ft.-lbs. is being obtained on steel castings with a tensile of 35 to 40 tons by controlling the grain size with the addition of a predetermined amount of aluminium as the deoxidised metal flows from the ladle to the mould. Two grades of steel are made for consumption by the locomotive carriage and wagon building shops and, of course, the British Standard Specifications are imposed. The process being acid, the choice of raw materials is limited.

The sulphur and phosphorus of the scrap have to be kept below 0.05 per cent., and there is a sulphur pick-up of 0.012 per cent. to be taken into consideration. However, there are at the disposal of the management excellent supplies of essentially suitable heavy steel scrap. The turnings used—9 cwts. in a 96-cwt. charge—are taken from the locomotive tyre shop. The runners and gates amount to a further 9 cwts. Usually the pig-iron addition is 1 cwt. of hematite.

The melting process is such that the same composition of furnace charge and melting procedure are applied for both grades of steel. A carbon content of about 0.2 per cent. is present in both steels, and the higher tensile required for the harder steel is obtained by increasing the manganese content by suitable alloy additions.

The carbon is controlled from bath samples by means of a Carbometer test. For this purpose a ½-in. dia. bar about 4 or 5 in. long is cast, cooled and dropped into a socket. Contact is made with a galvanometer and the readings are correlated with a table of carbon percentages. Providing the steel is reasonably free from alloys, the results obtained by what must surely be the quickest method ever devised are correct to within 0.01 per cent.

Fettling the Hearth

Where the technique at Crewe is superior to that practised at any other rotary-furnace plant the writer has inspected, is in the fusing on to the hearth after each day's casts of sufficient refractory to compensate for that removed during the previous heats. No attempt is made each time to make a complete concentric ring, the object being to deal with, say, a fifth or sixth of the diameter. After the next day's working an adjacent area is tackled, and so on until the whole surface of the furnace lining has been built up. The lining the writer inspected had made over a hundred casts, and he has since learned that 143 heats (which figure is a record to date) was obtained from this lining. Obviously this is one of the most important developments in the operation of rotary furnaces since their inception some ten years ago, and should its application to iron-melting plants be possible, then a considerable economy in operation can be anticipated. It naturally requires extra fuel for fritting, and there may be some loss in production time; yet it is well worth while because a standard cubic content in furnace capacity makes for ease and uniformity in operation. Despite these factors, however, the furnaces at Crewe are running with a fuel consumption of 7 cwts. per ton of metal at the spout, and the tapping temperature is of the order of 1,640 to 1,650 deg. C.

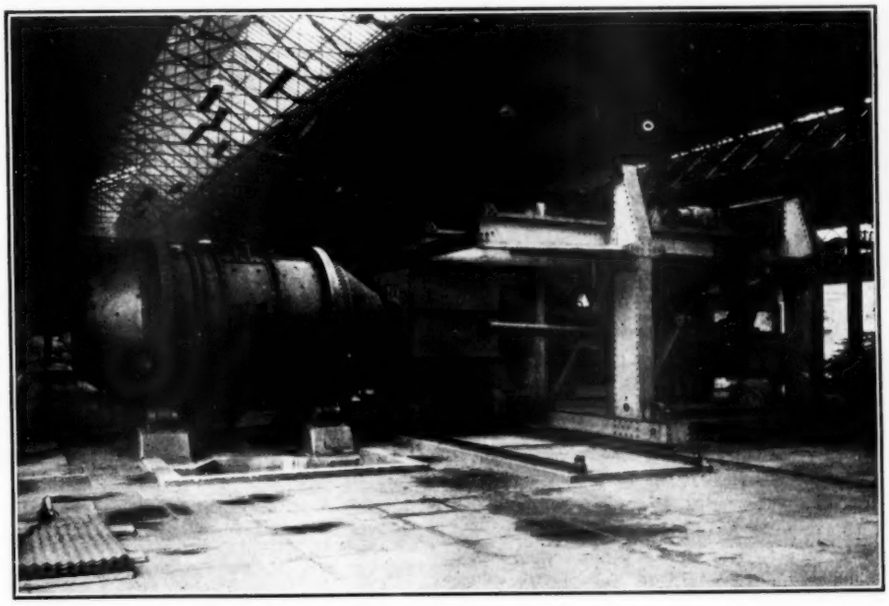


Fig. 3.—Close-up of the Sesci Furnace.

(*Concluded on page 250.*)

International Foundry Congress

PAPERS LISTED FOR PRESENTATION

The following Papers are expected to be presented to the International Foundry Congress, to be held in London from June 12 to 17 next.

No. 657.—FOURTH EDWARD WILLIAMS LECTURE: "The Atomic Pattern of Metals," by Prof. W. L. BRAGG, O.B.E., D.Sc., M.A., F.R.S., Nobel Laureate, Director of the Cavendish Laboratory in the University of Cambridge.

No. 658.—"Bonding Clays and the Properties of Synthetic Moulding Sands," by G. H. PIPER, B.Sc., Ph.D. (Presented on behalf of the British Cast Iron Research Association.)

No. 659.—"Core Shop Control," by J. J. SHEEHAN, B.Sc., A.R.C.Sc.I. (The Austin Motor Company, Limited, Birmingham.)

No. 660.—"The Selection and Testing of Cupola Refractories," by W. J. REES, M.Sc. (Department of Applied Science in the University of Sheffield.)

No. 661.—"The Gating of Castings with Reference to the Stream of Molten Metal," by DR. E. M. LIPS. (Presented on behalf of the Nederlandsche Vereeniging van Gieterij-Technici.)

No. 662.—"Some Iron Castings for Steelworks Plant," by J. ROXBURGH. (Davy & United Engineering Company, Limited, Sheffield.)

No. 663.—"Recent Developments in the Centrifugal Casting Process," by J. E. HURST. (President, International Committee for Testing Cast Iron.)

No. 664.—"Developments in the Centrifugal Casting Process in Germany," by W. A. GEISLER. (Fried. Krupp A.-G., Essen, Germany.)

No. 665.—"Specially Hard Alloy Cast Irons for Resistance to Wear," by DR. A. B. EVEREST and M. M. HALLETT, B.Sc. (The Mond Nickel Company, Limited, London.)

No. 666.—"The Thermal Conductivities of Some High-Duty and Alloy Cast Irons," by J. W. DONALDSON, D.Sc. (Scotts' Shipbuilding & Engineering Company, Limited, Greenock.)

No. 667.—"The Effect of Melting Conditions on Light Alloys," by A. J. MURPHY, M.Sc., S. A. E. WELLS, and R. J. M. PAYNE, B.Sc. (J. Stone & Company, Limited, London.)

No. 668.—"The Effect of Melting Conditions on Gas Unsoundness in Metals," by G. L. BAILEY, M.Sc. (Presented on behalf of the British Non-Ferrous Metals Research Association.)

No. 669.—"Pressure Die-casting in Zinc and Aluminium Base Alloys," by A. G. STREET, B.Sc., Ph.D. (Fry's Diecastings, Limited, Birmingham.)

No. 670.—"Light Alloy Melting Practice," by W. C. DEVEREUX, F.R.Ae.S. (High Duty Alloys, Limited, Slough.)

No. 671.—"Cutting Tools for Cast Iron," by H. BEENY, M.Met. (Alfred Herbert & Company, Limited, Loughborough.)

No. 672.—"Cupola Blast Volumes and Pressures," by DR.-ING. M. CZYZEWSKI. (Presented on behalf of the Stowarzyszenie Techniczne Odlewnikow Poskich.)

No. 673.—"Some Notes on the Design and Operation of the Open-Hearth Furnace for Melting Malleable Cast Iron," by G. R. SHOTTON. (Shotton Bros., Limited, Oldbury.)

No. 674.—"The Effect of the Nature of the Charge on the Properties of Cast Iron and Steel," by DR.-ING. P. BARDENHEUER. (Kaiser-Wilhelm für Eisenforschung, Düsseldorf.)

No. 675.—"Process of Crystallisation in Commercial Alloys," by PROF. E. PIWOWARSKY and DIPL.-ING. W. PATTERSON. The Foundry Technical High School, Aachen. (Presented on behalf of the Technischer Hauptausschuss für Giessereiwesen.)

No. 676.—"The Progress of Inverse Segregation during Solidification," by DR. J. A. VERO. (Presented on behalf of the Magyar Ontodei Szakem berek Egyesulete.)

No. 677.—"The Preparation of Alloys," by PROF. A. PORTEVIN. (Presented on behalf of the Association Technique de Fonderie de France.)

No. 678.—"Controlled Solidification of Castings made Possible by Calculation," by ING. N. CHVORINOV. (Presented on behalf of the Ceskoslovensky Odborny Spolek Slevarensky v Praze.)

No. 679.—"Copper and Copper Alloys for Electrical and Thermal Conductivity Applications," by H. J. MILLER, M.Sc. (Copper Development Association.)

No. 680.—"Making Steel Castings from Acid Electric Steel," by DR.-ING. PLESINGER. (Czecho-Slovakia.)

No. 681.—"Development and Organisation of Steel Foundry Research," by W. J. DAWSON. (Hadfields, Limited, Sheffield.)

No. 682.—"Radiography in Iron and Steel Founding," by F. W. ROWE, B.Sc. (David Brown & Sons (Hudd.), Limited.)

No. 683.—"Notes on Dry-Sand Practice for Steel Castings," by C. J. DADSWELL, Ph.D., B.Sc., Ing.E.S.F., and T. R. WALKER, M.A. (English Steel Corporation, Limited, Sheffield.)

No. 684.—"The Renaissance of the Steel Casting and the Rôle of the Metallurgist," by F. A. MELMOTH. (Presented on behalf of the American Foundrymen's Association.)

No. 685.—"Study of the Corrosion of Steel and Cast-Iron Pipes," by DR.-ING. L. OLSANSKY. (Czecho-Slovakia.)

No. 686.—"Foundry Education in Great Britain," by J. G. PEARCE, M.Sc., M.I.E.E., F.Inst.P. (The British Cast Iron Research Association.)

No. 687.—"Ten Years of Foundry Progress," by J. W. GARDOM. (Convener, the Technical Committee of the Institute of British Foundrymen.)

No. 688.—"Recommendations on Three Leaded Bronze Bearing Alloys," by the NON-FERROUS SUB-COMMITTEE of the Technical Committee of the Institute of British Foundrymen.

No. 689.—"The Influence of Repeated Remelting on the Properties of Light Alloys," by ING. HAJEK–DR. KORITTA. (Czecho-Slovakia.)

No. 690.—"Industrial Legislation in South Africa," Paper from the South African Branch of the Institute of British Foundrymen.

No. 691.—"The Solution Heat-Treatment of Aluminium Alloys," by DR.-ING. R. IRMANN. (Aluminium Industrie, A.-G., Neuhausen, Switzerland.)

No. 692.—"Malleable Cast Iron," by C. ZEHNDER. (Britannia Iron & Steel Works, Limited, Bedford.)

Papers numbered 680 to 685 will be presented at a session whereat the Iron and Steel Institute will participate.

A New Steelmaking Process

(*Concluded from page* 249.)

The Product

The castings made by this installation are in every way satisfactory, and compare very favourably with the standard reached by outside contractors. The locomotive wheels were machining up free from any draws or spongy places, whilst the skin was quite good considering the high casting temperature employed. The uniformity of the compositions as disclosed by the analytical and test-house records is as regular as those obtained by the older processes.

No attempt has been made to deal with costs, but it is thought that scattered throughout this article are figures which will enable executives to make a fair approximation of the major items. As the technique of fritting is still a comparatively recent innovation, a provisional figure of 1 cwt. per ton of metal melted is put forward.

The Future

The next step indicated in the development of pulverised-fuel rotary furnaces is the utilisation of a basic lining. Here much knowledge is still required of the expansion of the various refractories, the working out of a technique as to the best economic composition and constitution of the charge in relation to final analysis, the potentialities of sulphur reduction, and so forth. In its favour are complete freedom from acid material in the roof and walls, which would revolutionise slag control, and minimised disintegration on standing-by through a week-end owing to the ease with which the furnace can be sealed, or a gentle heat maintained. Moreover, being a rotary plant, fettling is facilitated owing to the possibility of draining a cavity quite free from slag and metal. Every melter well knows the great advantages this creates.

Conclusion

The author wishes to thank very sincerely Mr. W. A. Stanier, the Chief Mechanical Engineer of the London Midland & Scottish Railway, for his kind collaboration in the preparation of this article.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

497,215. FUERY, G. T. (Knight Products Pty., Limited). Composition for inhibiting the growth of rust on iron or steel surfaces.

497,264. AVERY, J. M. Method of operating blast furnaces.

497,270. STEWARTS AND LLOYDS, LIMITED. Method of producing thick-walled cup-shaped hollow metal bodies.

497,272. GROVES, W. W. (Akt.-Ges. für Stickstoffdunger). Means for adjusting the electrodes of electric furnaces.

497,307. ELECTRIC FURNACE COMPANY, LIMITED, and TAYLOR, G. E. Furnaces for heating metal and the like.

497,529. GRETHER, A. Centrifugal casting-machine.

498,076. JACKSON, L. MELLERSH- (Wolverine Tube Company). Apparatus for drawing seamless metal tubing.

498,086. FARMER NORTON & COMPANY, LIMITED, SIR J:, and NORTON, W. J. Bearings of rolling-mills.

498,261. RAFFLES, F. Making cast permanent magnets.

498,294. COMPAGNIE DES FORGES DE CHATILLON, COMMENTRY & NEUVESMAISONS, and THIBAUDIER, L. Casting of metallurgical ingots of great length.

498,324. SCHERF, E. Treatment of ore or rock containing iron and titanium.

498,367. GENERAL ELECTRIC COMPANY, LIMITED, and SMITHELLS, C. J. Method of manufacturing alloys of tungsten and/or molybdenum.

498,472. WEBSTER, W. R. Method of and apparatus for heat-treating metal strip, wire, or flexible tubing.

498,490. JAMIESON, J. Apparatus for cutting sheet metal or other sheet material.

498,517. HARGREAVES, L., TUDOR, H., HOOD, N. R., and IMPERIAL CHEMICAL INDUSTRIES, LIMITED. Degreasing metal articles.

498,637. ARDELT, R., ARDELT, P., ARDELT, R., and ARDELT, M. [trading as ARDELTWERKE]. Device for controlling the temperature of foundry moulds.

498,680. BARLOW, R., and HIDER, G. Method of and apparatus for coating sheet metal in strip or plate form, by dipping.

498,695. NORTON COMPANY. Method of and apparatus for grinding and abrading.

498,856. GREENAWALT, J. E. Method of sintering a charge of material.

498,860. GREER, A. J. R. Method of and apparatus for pickling metal.

Care and Maintenance of Control Instruments

By D. T. ANDERTON, B.Sc.(Eng.)

(*Concluded from page* 230.)

Pen and Pen Arm

One of the most important parts of a recording outfit is the pen and pen arm. A faulty nib may record poorly or even result in no records at all. A sharp pointed pen is liable to dig into the chart, and while this may give a record, it is certain to result in a pronounced lag in recording; it may even stop altogether. If the point is too broad, a thick record will result; this will decrease accuracy, apart from the fact that excessive ink will take longer to dry on the chart and so possibly lead to smudged records. Another cause of thick recording is too wide a split in the nib; in bad cases this may develop so that no ink at all is delivered, in which case the record stops. With the points apart in this way, the single points will also be sharper than when they are together, and there will be greater liability for them to dig in the chart. The pen will also fail to write when the points do not touch the paper evenly, or when the split is in the wrong place, say a little too much to one side.

It follows from these possible defects that it is an advantage to have nibs, pens and pen-arms renewable. They should also resist corrosion. When a pen becomes clogged with ink, or requires cleaning, it should be cleaned with a brush and some spirit solvent such as methylated spirits. In removing clogged ink special care should be taken not to open the split, otherwise one of the faults noted above will develop. Do not dry the pen after cleaning before refilling with ink; the ink should be put in the boat while it is still moist with spirit. It will be necessary, however, thoroughly to prime the split of the nib with ink after this, and it may best be accomplished by running a piece of thin metal foil along the split when the pen is filled with ink. Care must be taken not to fill the pen with too much ink. If it overflows and starts to run down the pen arm then it will continue gradually to drain away.

Incorrect length of the pen arm is another factor which can lead to inaccuracy where circular disc charts are used. This may be detected by keeping the disc chart stationary and then observing the effect of increase of temperature (or other variable being measured). The time should be stationary. If it is observed to increase as the variable increases then the pen arm is too long; if it decreases as the variable increases then the pen arm is too short. Errors of this nature may be corrected by very carefully bending the pen nib and so adjusting the length of the pen arm as required.

Clock Mechanisms

The clock mechanism should be thoroughly reliable, since any failure may mean loss of valuable records. It is advisable to have the clock wound regularly at the same time by the same person, unless it is electrically operated. Electric clocks require little attention other than oiling and cleaning every few years, and in a reliable power circuit they are much to be preferred to hand winding and adjustment. The time between oiling and cleaning periods for an ordinary clock mechanism should also be fairly long, but depends to a large extent on the service conditions, *e.g.*, the amount of dust to which it is exposed. Sometimes a clock runs slow and attendants try to correct this by hanging weights on the chart. This is a dangerous procedure, since it produces too much tension in the chart and may cause the clock mechanism to overswing. More rarely, too much chart tension may be produced by incorrect proportions of the roller on which it is fixed.

Protecting the Recorder

The method of installing a recorder and the protection it receives are not the least of the factors influencing its operation. The frequency of oiling and cleaning the clock mechanism will to a large extent be determined by the amount of protection the instrument receives. A dust and moisture proof case for the apparatus is advisable; in the presence of corrosive gases or fumes special precautions are advisable to protect the apparatus. It is folly unduly to expose a costly machine for the sake of a few shillings' economy. Leakage of a case is frequently found at the junction of the observation window and cover. Excessive vibration, in addition to being bad for the instrument, will also assist the development of leaks of this kind.

This question of vibration is important from another aspect. The sensitivity of recording temperature and pressure mechanisms depends on their magnification of a very small initial movement, and any excessive vibration is liable to upset this. The recording part of a measuring outfit should therefore be set up somewhere where vibration is at a minimum. The support arrangements should also be good. An insecure support will enhance any vibration effects and possibly be liable to accidental upset. In addition, it may settle, and so put the instrument out of level. With suspended coil galvanometers, and similar instruments, this want of level may lead to extremely inaccurate results. Shrinkage of a wooden support may cause trouble of this nature.

Bearings

It is desirable to look at the bearings of the instrument occasionally to determine if there is undue wear and friction. Inaccurate records are sometimes traced to a worn jewel surface, caused by too hard a pivot. It will be found occasionally that trouble is due to excessive wear of a too soft pivot. The bearings may advantageously be cleaned with spirits and a little chamois leather at the end of a pointed match; any odd specks of dirt which might increase wear will then be removed. Wear of a bearing may be due not to the bearing materials themselves, but simply to unnecessary vibration of the whole instrument.

Pressure Instruments

With pressure measuring instruments, it is necessary periodically to test for leaks at joints, etc. The best way to do this is to apply, very carefully, pressure or suction to the gauge through the line. The falling of the pointer back to zero after the end is sealed is an indication that a leak exists. The more delicate the instrument the greater the care required in testing so as not to overload it. If it is necessary to adjust the zero, the gauge should first be opened to atmosphere; a screw is usually provided for bringing the pointer back to zero.

Draft recorders for modern boiler-house use generally magnify the pressure difference to facilitate observation. In liquid column gauges the correct amount and type of liquids have to be replaced if displaced at any time owing to excess pressure; evaporation losses must also be made up. A little oil covering the surface of water, if used, will prevent evaporation. Vacuum box instruments should be checked for some time after installation, since they take some time to settle down into a comparatively stable state. A protective coating of tin should be given to the gauge where exposure to corrosive gases is likely.

Bourdon tube gauges should not be exposed to much heat; Bourdon tubes should not in any case be exposed to temperatures higher than 150 deg. Fah. The resiliency of the tube may be impaired and under the combined action of heat and pressure the solder around the connections may melt. It is always best to fit a syphon between a gauge and a steam main to prevent direct contact of the steam on the bourdon tube. This syphon should be examined periodically to see that it is condensing steam and thus functioning correctly. A syphon of oil is similarly advantageous where the gauge is exposed to a corrosive chemical or gas; dangerous thinning of the tube is then avoided.

Constant vibration is not good for any gauge, since it is liable to loosen the mechanism or wear away some parts and so cause the mechanism to stick at certain points. Constant oscillation of the pointer should be countered by fitting a cock between the gauge and source of pressure. The pressure can be throttled down to minimise the oscillation, which will shorten the life of the gauge if allowed to continue at will. A double spring gauge is well worth consideration for such a location, since fluctuation is minimised.

Finally, the size of the gauge is a great factor. The most suitable gauge for any service will have a dial calibrated to about twice the pressure required, so that in service the pointer will usually read in a vertical position. This favours accurate measurement and also lengthens the life of the gauge.

Flow Meters

Various types of flow meter are in use. One of these is the revolving drum type used for measuring wet gas. The drum rotates inside a casing containing water and operates a pointer by means of a spindle passing through a stuffing gland. For accurate reading it is necessary to keep the instrument level, and also to keep the water-level constant at a specified mark. The friction set up by the stuffing gland should allow the drum to rotate without causing any surging of the water in the gauge glass.

Orifice steam flow meters operate successfully only when the orifice fittings and pressure pipes are clear of leaks and blockage. It is advisable to clear the pressure pipes three or four times annually by blowing through them thoroughly; meter valves should, of course, be shut while such cleaning out is being effected. Corrosion is liable to change the diameter of the orifice and must therefore be checked. It will be worth while to use orifices made of Monel metal or stainless steel. The zero reading should be checked every month or six weeks, as follows: Close the low pressure valve, open the equalising valve, and then close the high pressure valve—the pointer then moves slowly to the zero mark, enabling any slight adjustments to be made.

The care of the clock mechanism, pen and recording unit has already been discussed. It may be remarked, though, that when regulating a clock it is better for it to be less than ½ per cent. fast rather than slow, since it will tend to slow up when in service. All pressure pipes from the orifice to the recorder should be kept full of water. If the meter is above the orifice, air-collecting chambers fitted with air vents should be provided on the pipes.

In steam meters of the electrical type the upstream and downstream pressures are connected to the two limbs of a mercury U gauge. Mercury, of course, is extremely mobile and therefore assists accuracy owing to its instant response to minute fluctuations. With instruments of this type it is essential that the lines be blown free from sediment once a month. Any collection of sediment, apart from the restriction effect, tends to amalgamate with mercury. This makes the mercury less fluid and also gives bad electrical contacts. The mercury should be regularly examined for such

contamination and cleaned whenever necessary as follows. The mercury is first poured through a filter paper folded in the ordinary way but having a pin hole in its apex. This removes the solid impurities. To remove the soluble ones the fine stream of mercury passing through the filter should be run through a long column of nitric acid (Sp. Gr. 1.2) contained in a vertical glass tube with a suitable tap at the bottom. Another filter may then be fitted up for running this product through a similar column of water in the same way; this washes out the acid. The collected mercury is finally dried in an oven at 120 deg. C. Opportunity should be taken to clean the contact rods of the steam meter while the mercury is being cleaned.

Venturi and Pitot Tubes

Venturi tube meters are particularly sensitive to obstructions in the throat, and periodic removal of deposits is necessary. Sometimes, if gases are being measured, the throat may be heated to prevent depositions such as tarry matter. As a rule reversal of flow through the meter is likely to cause damage to the meter. The development of air locks should also be prevented, otherwise inaccurate results will follow. Pitot tubes are not normally troublesome, except for the possible development of internal leaks from one tube to another in the concentric type of tube. These should be tested occasionally for such a leak.

Some of the most widely used and important instruments in modern industry are those used for the control of combustion processes in the steam-raising plant. The key indication of the efficiency of combustion of the fuel is the percentage of carbon dioxide in the flue gases. This is sometimes confused with the efficiency of the boiler as a whole. Actually, of course, the amount of carbon dioxide is merely a measure of the efficiency with which heat is being produced, whereas the real boiler efficiency is largely determined by the efficiency with which the heat is absorbed. The latter is measured by the temperature readings on the plant.

CO_2 Measuring Devices

The instruments for measuring carbon dioxide are of various types, operating on a chemical, electrical or physical basis. Chemical instruments absorb the gas in potash solution. These have the disadvantages of necessity for renewal of the reagent periodically, glass construction needing careful handling, considerable time lag indication, and sulphur dioxide being shown as carbon dioxide. The inclusion of glass taps as in the familiar Orsat can cause sticking, due to contact with potash solution. When trouble of this kind occurs it is best to immerse the tap in water which is being gradually heated, and to tap the barrel with a light object such as a small glass stopper. When the tap is fixed in the apparatus in such a way that complete immersion is not possible, it should be wrapped in a hot damp cloth, this cloth being removed prior to each bout of tapping with the glass stopper.

Tap loosening in this way is a delicate and lengthy business, and it is much wiser to take adequate precautions to prevent any sticking of taps. Regular periodical turning of taps, whether the instrument is being used or not, will serve to detect any stiffness and this may be corrected immediately by regreasing.

A Good Grease for Taps

A good tap-grease can be made by warming the following mixture to a gummy consistency: rubber 16, vaseline 18, paraffin wax 20, all as parts by weight. A convenient storage vessel for this grease is a wide-mouthed jar. It should be applied with the finger as a thin layer, particular care being taken to avoid capillary holes. Whenever removing a tap for regreasing the plug should never be put down anywhere where it can pick up dust or dirt. Such material, if introduced into the barrel of the tap, will tend to scratch the barrel, and this in turn will lead to leaks and possibly breakage at the barrel.

Another potential source of trouble in this type of apparatus is rubber tubing used for connections, since this is likely to develop cracks on perishing, with consequent leakage. The rubber will perish quickest at those parts where it is stretched, as over connecting pieces. The best way of combating this is to renew the tubing at regular short intervals. The potash solution also requires renewing, though this will depend more on the amount of use it receives. It is wise to keep a record of the number of running hours, and the total hours since the last charge, from which it can be seen when new alkali is required. It is usually safer, too, to renew the solution when the apparatus has been idle for some length of time.

Physical Carbon-Dioxide Recorders

Physical recorders of carbon dioxide depend on the physical properties of the gas for their action. The different resistances which gases encounter when passing through small capillary tubes or orifices can be used to determine the carbon dioxide content of a mixture of gases. This type of instrument is very free from time lag. Erroneous readings can result, however, from any dust particles present, since these will increase the viscosity of the gas. It is imperative, therefore, that the filter attached to the instrument should be effective.

The dust filter should be regularly cleaned, at least every six months, by disconnecting from the apparatus and blowing compressed air through it in the reverse direction to that taken by gases in normal service. The connecting pipes are cleaned by blowing steam through them. Carbon monoxide cannot be measured by this type of instrument, since its physical properties are unsuitable for the purpose. Usually, it is measured by first passing the gas over to determine carbon dioxide, then passing the gas over heated copper oxide to convert any monoxide to dioxide, and finally measuring the percentage increase in dioxide for the carbon monoxide.

Electrical indicators show both monoxide and dioxide. They operate on the basis that if a hot solid is surrounded by a gas some of the heat is conducted away, the amount of heat so dissipated being dependent on the thermal conductivity of the gas. The thermal conductivity of carbon dioxide is about one-half of that of air, which means that if two wires are heated electrically to the same temperatures, one surrounded by an atmosphere of dry air and the other by flue gases, the wire in the flue gases will cool slowest. The difference in the resistance of the two wires resulting from this can be used to measure the carbon dioxide content.

The measurement of carbon monoxide is complicated owing to the fact that its thermal conductivity is about the same as that of air. This gas must therefore be first burnt to carbon dioxide by a hot wire; the heating effect of this combustion changes the resistance of the wire and so gives a measure of the monoxide present. It will be appreciated that with these instruments it is essential for the filter to remove soot, etc., efficiently. Filter attentions have already been described above.

Transportation of Instruments

The importance of careful handling during transit scarcely needs emphasis; careful installation and usage on site will be of little value if the instrument has been knocked about much and upset during transit from another location. If it is possible to check the instrument before and after transit, it is well worth while; it is always comforting to be certain that no harm has been done, and even if something has been upset, then that method of packing or transportation can be condemned as of little future use. Apparatus without its own case should be packed in a strong temporary one, using some form of semi-resilient packing, such as corrugated cardboard.

A Gating Problem

BY "SKIMMER."

The iron casting shown in Fig. 1, though comparatively simple to mould, set up a problem for the moulder, which, before it was solved, caused much annoyance, loss of time and money. The casting, made in a three-part box, weighed 40 lbs., was 12 in. long by 8 in. diameter, and was to be machined on the outside. The nature of the work to be performed by the finished casting, when fitted into the machine, called for a perfectly clean surface and free from any kind of defect.

The pattern was rammed up in green-sand and a riser was placed on the boss. The metal entered the mould through one gate at the bottom and hot iron, straight from the cupola was used. A chamber-core was inserted and guided through a hole in the top-part to keep it central.

The first order of twenty castings went in the machine-shop, but seventeen came back to the furnace, one cut of the tool exposing a patch of fine scum about four inches from the bottom of the casting. Six more castings were moulded and four of them had to be scrapped.

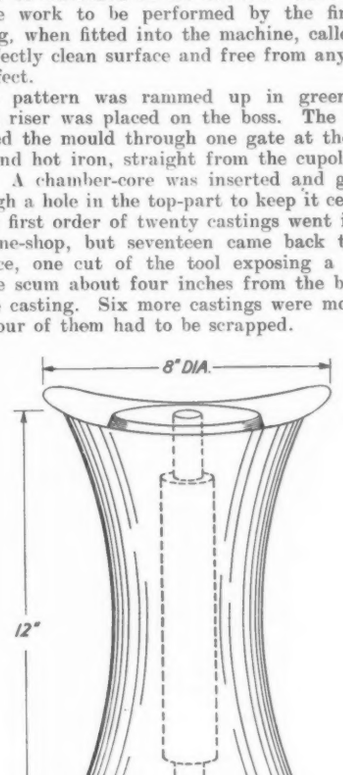


FIG. 1.

It was then that the writer became interested, and he made a close investigation for a possible cause, rejecting the generally accepted one of dirty iron, as the same metal was being used for other machine work, equally as important and with no rejects. With the aid of a magnifying glass, the small, sponge-like holes were seen to contain particles of burnt sand, which could be picked out on the point of a knife. It was then suspected that the oil-sand core, receiving the full force of the 40 lbs. of high-temperature iron from the one gate, was beginning to wash away by the time the mould was full, the loose particles of sand floating up and adhering to the circular wall of the mould. This was an indication that the quality of the oil-sand was open to question.

The method of gating was altered, and, instead of filling the mould with one gate at the base, eight thin spray gates were cut round the top, the idea being to distribute the volume of molten metal entering the mould, thereby considerably reducing the eroding action set up by the extreme heat of the iron. The gating by eight spray top-gates was a success. Each spray ensured a gentle flow of white-hot metal without any fear of the iron eating into the core. The part of the mould where the searching heat of the iron struck the sand was given a protective coating of plumbago rubbed well in with the finger tips. No more trouble was experienced.

Melting Practice in a Large Engineering Iron Foundry

By W. W. BRAIDWOOD

(*Continued from page* 240.)

Cycle of Charging Operations

Emptied buckets are deposited on the "descent platform" under the monorail, and before No. 1 Bin. A lifting bar is then engaged, and the bucket raised just clear of the concrete slab, the upper surface of which is 3 in. above ground level. This operation occupies only a few seconds.

The first constituent of the charge, generally purchased cast iron scrap, is then weighed in, and the bucket, attended by two men, proceeds to the subsequent bins, where the other constituent metals, in similar fashion, are simultaneously charged and weighed, the final metal weight being obtained with particular accuracy. Coke and limestone are then weighed in, the bucket lowered through a fraction of an inch on to the "ascent platform," and the charged bucket subsequently elevated to the cupola platform.

(The purpose served by the "ascent" and "descent" platforms has probably already been realised. A height of 3 in. to 4 in. between bucket and floor is necessary in order to avoid contact with the small pieces of scrap, etc., generally encountered during circuit of the bins, and also to bring the level of the bucket rim to that height found most desirable by the attendants. Provision of 3 in. thick slabs at the sections stated renders the required height obtainable and relinquishable with a minimum expenditure of time and energy.)

Six weighing units are in use, in conjunction with twelve buckets. These numbers are sufficient to prevent hold-up at any point, even during the peak periods, and make possible the retention, on the platform, of several charged buckets in reserve.

The actual charging operation is illustrated in Fig. 7. A jib crane, underslung from twin members erected over the whole length of the platform and running parallel with the cupolas, is employed for this purpose. This charger, of Babcock design and construction, travels longitudinally and laterally, hoists and lowers through a vertical distance of over 5 ft., and swivels completely in either direction, all of these movements being controlled from a push-button block suspended from the crane. The aperture of each cupola is shaped to permit the bottom to move open, depositing the contents steadily within the cupola. The speed of discharge is, therefore, controllable, and charging may be prompt or gradual as the occasion requires.

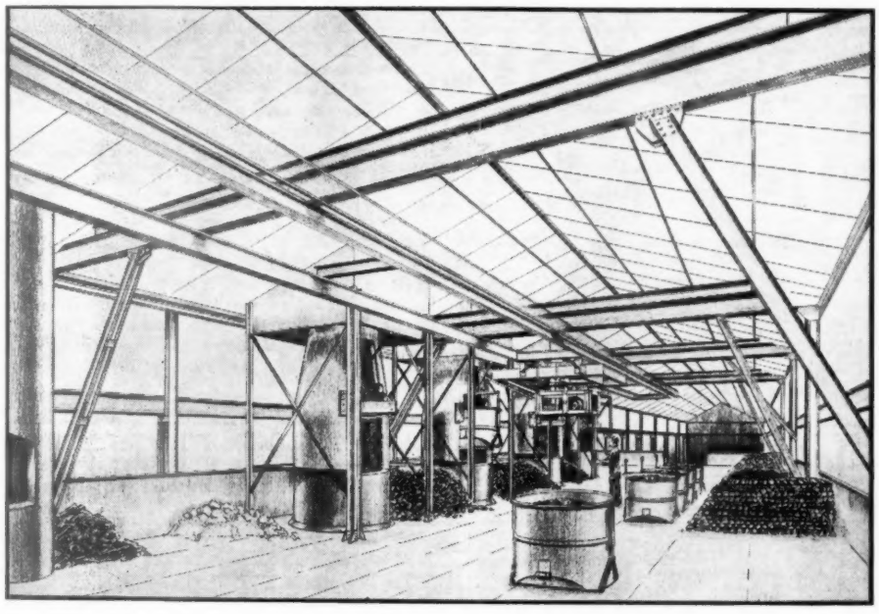


Fig. 7.—Cupola Charging Platform, showing Handling Methods.

The Charging Routine

One cupola is kindled on the previous day, and the bed allowed to burn, very gently, overnight. Also, on the previous evening, after completion of charging and while the cupolas are blowing down, all twelve buckets are loaded. One contains coke only, in sufficient amount to raise the bed to the desired height, and the first operation next morning is the charging of this coke. The furnace is then promptly filled from the remaining buckets, and a typical log of this initial procedure, during the extremely busy period of a year ago, reads:—

6.00 a.m.—Start—coke charged.

6.20 a.m.—Furnace fully charged—blast on.

6.45 a.m.—Approximately 2 tons melted—tap-hole opened.

The "all-day" cupola normally melts Grade "C" cast iron only, and is kept filled to sill level with identical charges until late afternoon.

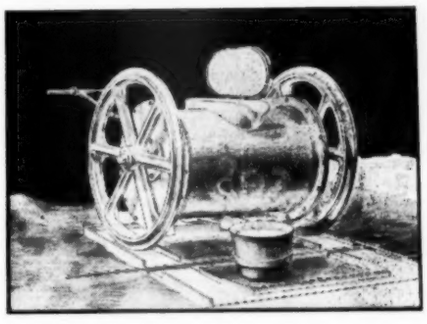


Fig. 8.—Type of Bogie Used and Pouring Station.

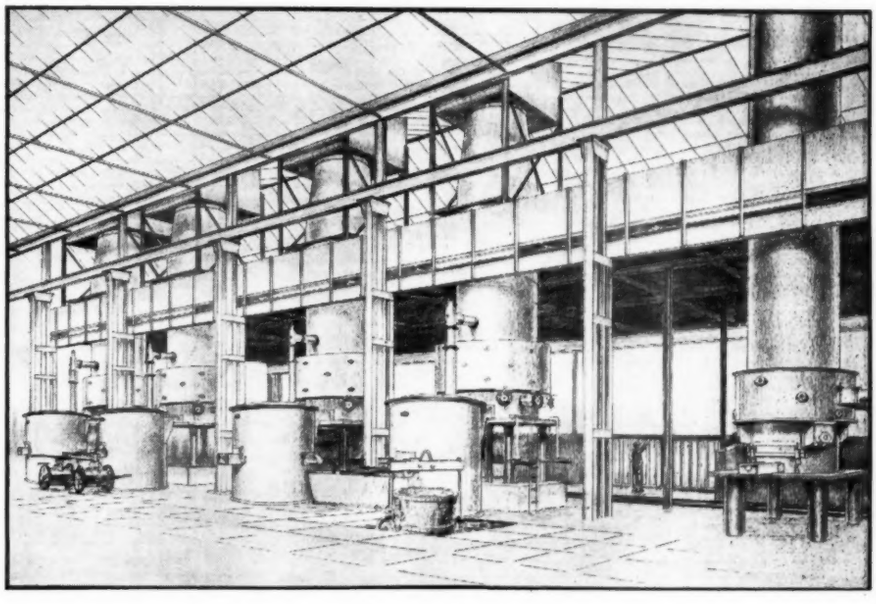


Fig. 9.—Appearance of Cupola Plant at Ground Level.

entry of a bucket suspended from the jib, and the operation of charging is simple. The loaded bucket is passed into the cupola, and the jib lowered. The downward movement of the bucket is arrested when the top angles meet the cast iron bearers built into the side walls, and further lowering of the jib allows the hinged

A morning consultation with the moulding foreman precedes preparation of the charging arrangements for the second cupola. This list of the special charges is generally available by 9 a.m., and shows on one side the particular castings in their planned pouring sequence, the metal grade employed in each instance being

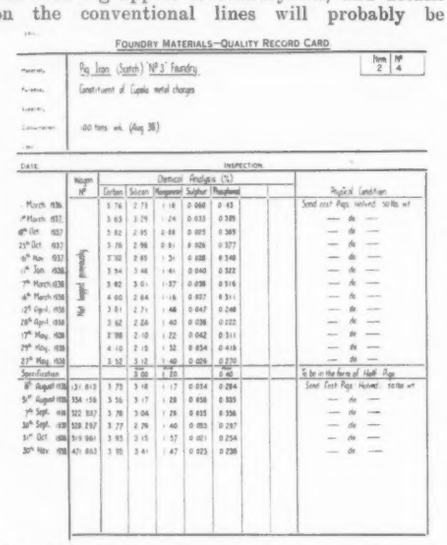
denoted by symbols in an adjoining column. On the reverse side, the constituents of the required charges are detailed, in order. This programme passes first to the charging squad, then consisting of five men at ground level. They thereupon commence preparation of the special charges, simultaneously with those required by the cupola in operation. By late forenoon, the second cupola, the bed of which was kindled at the start of the day, is fully charged and ready to be put in blast. The list then passes to the tapper, and, on completion of pouring, to the labour-squad leader, who is then enabled to identify and eventually to return the scrap metals of various grades to their proper sections within one of the charging bins.

Accurate weighing of all of the constituents of each charge profoundly influences the performance of a cupola. At Renfrew, the constancy of the metal temperature is rivalled only by the uniformity in composition of the tapped metal. A further advantage of this careful preparation is that quite considerable proportions of miscellaneous cast iron scrap, of cheap quality and indeterminate composition, may be utilised without much risk of obtaining metal of erratic analysis. In personal experience, the Grade "C" charges, normally composed within the following limits:—

	Approximate %
Miscellaneous cast iron scrap	25-30
Cast iron scrap of known composition	35-30
Foundry pig irons	40

produce metal of very constant composition, as will be shown.

Metal to coke weight ratios are usually accepted as the criterion of economical cupola operation. This standard of measurement, though palpably open to criticism, undoubtedly has a strong appeal to foundrymen, and details on the conventional lines will probably be


FOUNDRY MATERIALS—QUALITY RECORD CARD

Pig Iron (Scotch) No 3 Foundry.

Item 2 | No 4

Constituent of Cupola metal charges

100 tons wk. (Aug 38)

DATE | INSPECTION

	Wagon No	Chemical Analysis (%) Carbon	Silicon	Manganese	Sulphur	Phosphorus	Physical Condition
March 15th	Not tapped previously	3.76	2.73	1.18	0.060	0.43	Sand cast Bars Notched 30 lbs wt
4th March 1937		3.63	3.29	1.24	0.033	0.309	— do —
6th Oct. 1937		3.82	2.95	0.88	0.005	0.369	— do —
25th Oct. 1937		3.76	2.98	0.81	0.026	0.377	— do —
6th Nov. 1937		3.82	2.85	1.21	0.028	0.340	— do —
17th Jan. 1938		3.54	3.48	1.41	0.040	0.322	— do —
7th March 1938		3.82	3.01	1.27	0.038	0.316	— do —
16th March 1938		4.00	2.84	1.16	0.027	0.311	— do —
12th April 1938		3.81	2.71	1.48	0.047	0.248	— do —
28th April 1938		3.62	2.26	1.40	0.038	0.222	— do —
17th May 1938		3.98	2.10	1.22	0.042	0.311	— do —
29th May 1938		4.10	2.15	1.32	0.054	0.416	— do —
27th May 1938		3.52	3.12	1.40	0.026	0.270	— do —
Specification			3.00	1.20		0.40	To be in the form of Half Bars
16th August 1938	131 613	3.73	3.18	1.17	0.034	0.284	Sand Cast Bars Notched 30 lbs wt
5th August 1938	354 156	3.56	3.17	1.28	0.058	0.335	— do —
7th Sept. 1938	322 337	3.78	3.06	1.29	0.035	0.336	— do —
26th Sept. 1938	328 297	3.77	2.29	1.40	0.053	0.297	— do —
31st Oct. 1938	319 961	3.93	3.15	1.57	0.021	0.254	— do —
26th Nov. 1938	401 663	3.91	3.41	1.47	0.023	0.238	— do —

FIG. 10.—QUALITY RECORD CARD FOR FOUNDRY MATERIALS.

welcomed. The Grade "C" charges comprise:—

Metals	17 cwts.
Coke	133 lbs.
Limestone	35 lbs.

and give the weight ratio, "Metals charged" to "Coke charged," of 14.3 to 1.

In the case of charges for the Grade "A" and other special cast irons, however, where the tapped metal is required to be exceptionally hot, the total weight of the metal charge is reduced to a minimum of 12 cwts., the quoted ratio thus becoming a minimum of 10.1 to 1.

The routine practice is to make the last four charges of each melt without coke. This procedure effects a saving in coke without causing overmuch fall in the temperature of the tapped metal, and also gives a really small and easily-handled "drop." The necessary weight of bed coke has already been indicated, and it remains only to be stated that the normal overall weight ratio of "metal melted" to "coke consumed," taken over the normal total melt from these cupolas, and including all special charges, is somewhat higher than 12 to 1.

Cast irons to satisfy all of the existing British Standard Specifications are produced from these balanced-blast cupolas, but it is impossible, within the bounds of the present Paper, to enter into detailed discussion of charges or associated technique.

Personnel

The staff engaged in the operation of these cupolas in the manner described, totals fifteen men and one youth, this complement including charge-hand, tappers, fettlers and attendants, loaders and crane operatives. Payment is made partly by basic time rates and partly by equal participation in a tonnage bonus, the ultimate "direct labour" cost being 2s. 2¾d. per ton of metal melted.

LOG OF MELTING PROCESSES

	METAL	FURNACE No — METAL CHARGES								FURNACE MATERIALS						METALS CHARGED TO CRUCIBLE FURNACE													SPOUT ADDITIONS ETC.		METALS CHARGED TO CUPOLAS								
CODE No										25/36	27/278	47/268	27/187	27/183	1/1	2/111	2/111	6/4	48/286	46/284	48/283	48/286	48/286						46/286	48/286	0/1	0/1	2/1	2/4	2/111	6/4	27/268	Own	
	Grade	1	2	3	4	5	6	7	8	Fuel Oil	R.M.	Clay	Flux	Coke	Copper	Ferro-Mn	Ferro-Si	Steel	Fe-Mn	Fe-Si	Fe-Chr	Nickel	"F"	Scrap	Total	Fe-Chr	"F"											
Units										Gallons			Tons								lbs							lbs						Tons				
Monday	A.			6			17							0·43																1·00				1·20		0·60		3·60
28/11/38	B.			9										0·65																5·40								5·40
	C	99		53										0·99																	52·25	12·90				52·25	52·25	109·65
	H.R.3.					5				65					·	709	·	336	8	114	36	229	98	360	1,800													
	W-W.R.				12									0·85														10						0·90	0·90		1·80	3·60
Blast on:		8·48		1·00	4·08																																
Blast off:		9·08		8·20	5·30	6·15																															
Tuesday	A.				15									0·92																3·90				3·90		1·50		7·80
29/11/38	B.				9									0·64																5·40								5·40
	C		96		36									0·71																		13·20	22·00				33·00	33·00	112·20
	H.R.3					5				62					·	705	·	350	10	93	50	·	292	315	1,815													
	W-W.R				12									0·85														10						0·90	0·90		1·80	3·60
Blast on:			8·15		4·00																																
Blast off:			5·00		8·45	5·30	5·40																														
Wednesday	A			8										0·58																2·65				1·55		0·80		4·80
30/11/38	B			9										0·65																5·40								5·40
	C	99		34										0·98																		12·98	92·25				30·30	34·20	109·65
	H.R.3					5				88					·	705	·	350	10	92	50	·	293	300	1,800													
	W-W.R				11									0·88														12						0·80	0·85		1·65	3·30
Blast on:		8·15		1·00	4·00																																
Blast off:		5·15		8·20	5·20	4·00																															
Thursday	A - H.T.				11									0·70														13				3·50				2·00		1·10		6·60
1/12/38	B				9									0·65																5·40								5·40
	C		95		32									0·42																		12·70	91·75				30·50	33·00	107·95
	H.R.3					4				53					·	564	·	280	8	74	40	·	234	240	1,440													
	W-W.R				12									0·85														10						0·90	0·90		1·80	3·60
Blast on:	"		8·05		1·00	4·00																															
Blast off:			5·00		8·35	5·20	1·45																															
Friday	A			14										1·02																3·85				3·15		1·40		8·40
2/12/38	B			9										0·65																5·40								5·40
	C	92		27										7·09																		11·90	29·75				29·75	29·75	101·15
	H.R.3					4				79					·	423	·	210	8	55	30	·	176	548	1,440													
	W-W.R				9									0·70																					0·70	0·65		1·35	2·70
Blast on:		8·20		12·40	4·00																																
Blast off:		4·40		5·55	5·15	8·00																															
Saturday																																					
3/12/38																																					
Blast on:	No																																				
Blast off:	Melting																																				
Individual Totals for Week	"A"												8·85	3·74																15·30				10·70		5·20		31·20
	H.T. —— ("A" base plus :—																											12										
	B												0·70	3·24																27·00									27·00
	C												9·95	42·19																	32·25	63·60	126·75				155·80	162·20	540·60
	H.R.3									310					·	3186	·	1524	42	428	226	220	1054	1695	9,295													
	W.												8·55	4·05																				4·20	4·20		8·40	16·80
	W.R. —— ("W" base plus :—									310																		42										
Combined Totals :										310	8·00	4·00	1205	113·22		3106		1524	42	428	226	220	1054	1695	8,295	42	12						42·50	32·25	63·60	126·75	4·20	14·90	155·80	175·80	615·60
Absolute Totals :																						268		1066													15·58			619·50
Stocks at end of previous week :										540	55·20	7·00	35·46	304·25					463	664	2885	456	4500								1102·75	85·00	73·10	545·25	53·70	33·45	133·15		
Balances remaining :										230	47·20	3·00	23·41	251·01					421	236	2817	236	3434								1059·05	52·75	9·50	216·50	49·50	17·87	— 22·65		
Deliveries during week :										-	11·00	-	35·36	109·00					-	-	-	-	-								382·05	343·20	-	-	-	6·60	224·90		
Present Stocks :										230	58·20	3·00	58·77	360·01					421	236	2817	236	3434								1641·11	395·95	9·50	216·50	49·50	24·47	202·25		
Still on order :										2,000	Contract	16·00	-	Contract					-	Transfer	-	2240	4480								260·00	1636·00	-	-	-	Transfer	Contract		

FIG. 11.—LOG OF CUPOLA MELTING PROCESSES.

By a smooth system of relief, charging staffs are maintained during the works' dinner-hour, when melting is uninterrupted, and are augmented during the peak hours of the afternoon, all by interchange within the ranks of the personnel enumerated.

Emergency Stocks

Stocks of all purchased constituents of the furnace charges are maintained upon the cupola platform, ready for use in the event of a mechanical breakdown. Actually, these stocks would be sufficient to keep the furnaces supplied throughout a full day's melt, this arrangement being an effective insurance against the possibility of a major breakdown occurring in the early morning.

centre of gravity and the safe employment of roller bearings.

(3) Transport is much safer, since splashing is quite prevented.

These advantages are all very real, and, in conjunction with the greater degree of convenience afforded the user, have made this type of bogie a very popular innovation.

The drawing requires correction in two of its details. The hinged lid, shown in the open position for illustrative purposes, is closed at all times other than during the actual operation of filling. The eccentric mounting shown is employed only on that type of bogie designed for transport by crane, in which case it serves to provide an effective counterpoise, on tilting, to the moment gained by the lifting frame.

and daily attention is confined to repair of the lip and lid.

Fig. 9, a front view of the cupolas, shows drum-type bogies in position for filling, and also features a ladle-pit, uncovered and containing one of the large ladles.

Technical Control of the Foundry Product

At Renfrew, this begins with control of all raw materials. These are tested and evaluated in many ways, the results of all such determinations being carefully logged on "quality record cards" of the form illustrated. (Fig. 10.) This procedure, initially, assists in the establishing of specifications, and, subsequently, ensures their observance.

Only furnace materials, however, come within the scope of this Paper, and that featured is,

METALLURGICAL RECORD

Date of casting	Sample Submitted: Symbol	Sample Submitted: Form	CHEMICAL COMPOSITION: Carbon: Total	Carbon: Combined	Silicon	Manganese	Sulphur	Phosphorus	Chromium	Nickel	Copper	PHYSICAL PROPERTIES: Micro-Structure.	Transverse Test: Condition of bar	Transverse Test: Dia.	Transverse Test: Span inches	Transverse Test: Deflection	Transverse Test: T.R.S. Tons/□"	Tensile Test: Strength Tons/□"	Tensile Test: Elongation %	Hardness: Specimen	Hardness: Brinell No.	Remarks.
Monday 28/11/38								%				Heat treatable Cast Iron.										
	C.	1" × 1" × 6" Plug.	3·39	0·45	2·36	0·59	0·096	0·691				Effect of heat treatment on 2½% Nickel Cast Iron.	AC-56	1·18	18	0·28	22·8					No 1 - 11 a.m.
	C.	1·2" Dia. Test Bar.	3·41	0·39	2·36	0·61	0·085	0·702														No 1 - 3 p.m.
	W.	1" × 1" × 6" Plug.	3·03		0·54	0·28	0·152	0·947														
Tuesday 29/11/38	As	1·2" Dia. Test Bar	3·23	0·46	1·90	0·98	0·087	0·343					AC-56	1·17	18	0·47	38·8					
	C.	1" × 1" × 6" Plug	3·61	0·32	2·36	0·59	0·075	0·840														No 2 - 11 a.m.
	C.	1" × 1" × 6" Plug	3·46	0·28	2·36	0·63	0·090	0·755														No 2 - 3 p.m.
Wednesday 30/11/38	B.	1" × 1" × 6" Plug	3·80	0·17	2·90	1·08	0·091	0·8102														
	C.	1" × 1" × 6" Plug	3·46	0·41	2·24	0·33	0·098	0·745				Etched 2% Nital × 350 Diams "as cast" condition										No 1 - 11 a.m.
	C.	1" × 1" × 6" Plug	3·56	0·34	2·27	0·59	0·079	0·840												(for shop test)		No 1 - 3 p.m.
	W.R.1	1" × 1" × 6" Plug	3·44		0·24	0·34	0·123	0·642	0·23										Mill Liners (18" Av. Section)	580		3 lbs Fe-Chrome opp. Brazil Nut size (84·6% Chr. 4·7% C.) added to 896 lbs Total Tap. Efficiency of addition = 100%
Thursday - H.T. 1/12/38		1·2" Dia. Bar	3·15	0·58	1·61	0·71	0·074	0·194	-		2·38								1·2" Dia × 3"	250		Cooled in mould. Four tests on transverse bars. Average quoted
	C.	1" × 1" × 6" Plug	3·45	0·32	2·43	0·68	0·091	0·783											1·2" Dia × 3"	426		Same test piece and procedure, after oil-quench from 850°C
	C.	1" × 1" × 6" Plug	3·50	0·35	2·38	0·68	0·091	0·788														
	H.R.3	1·2" Dia. Test Bar	2·94		5·33	0·95	0·033	0·157	2·01	17·87												No 2 - 11 a.m. No 2 - 3 p.m. Flaw. Crucible melt
Friday 2/12/38													AC-56	1·53	18	1·25	28·6					
	C.	1" × 1" × 6" Plug	3·38	0·32	2·54	0·65	0·077	0·729														No 1 - 11 a.m.
	C.	1" × 1" × 6" Plug	3·52	0·28	2·56	0·65	0·070	0·756				Etched 2% Nital × 350 Diams Oil-quenched from 850°C										No 1 - 3 p.m.
	W.	1" × 1" × 6" Plug	3·43		0·68	0·43	0·150	0·038														
Saturday 3/12/38																						
28/11/38		Pig Iron	3·93		3·41	1·47	0·023	0·238														In accordance with specification.
1/12/38		Pig Iron	3·77		3·18	1·65	0·045	0·478														Internally in accordance with specification.
3/12/38		Purchased C.I. Scrap	3·33		2·22	0·56	0·083	1·29														Medium - Light section. Moderately clean. (Wagon No 137.058)

Spout addition of Chromium, using 4 - 6% Carbon, Ferro-Chrome approximately of Brazil Nut size, established as 100% effecient for the percentage addition observed.

Heat - treatable Cast - Iron (2½% Nickel) Hardness increase on quenching in oil from 850°C observed to be of the order of 200 Brinell.

Drum type bogie re-lined. Metal capacity 10¾ Cwts. Put into service on C.C. Plant 2/12/38.

Pig Iron analysis not quite within specification. Keep closer check on future consignments.

FIG. 12.—METHOD OF RECORDING METALLURGICAL DATA. (THE PHOTOMICROGRAPHS, BEING MUCH REDUCED, ONLY ILLUSTRATE THE SYSTEM OF RECORDING.)

Transport of Molten Metal

Until some months ago, distribution of hot metal throughout this foundry was effected entirely by means of geared ladles and wheeled bogies of the traditional cup shape. Following, however, upon the successful trial and subsequent improvement of the drum-type bogie illustrated in Fig. 8, replacement of the existing bogies is proceeding, while the construction of an experimental geared ladle of this type is contemplated. The main advantages attending the use of vessels of this design are:—

(1) Heat losses are considerably reduced, mainly by prevention of unimpeded radiation.

(2) Ease of movement in pulling and pouring is greatly increased, by reason of the low

Pouring stands of the type illustrated are placed at strategic points throughout the foundry, adjoining and at right angles to the roadways. Bogies are thus easily drawn off the passageways, and safely secured while the contents are tapped into shanks, etc.

The capacity of the newly-lined bogie is rather more than 10 cwts. of metal, the lining being prepared by ramming a suitable refractory material around a former. In order to ensure complete emptying of the contents, the lining thickness should taper from both ends towards the centre. This is successfully accomplished, at Renfrew, by the employment of a hinged, collapsible pattern, and the re-lining of a bogie is a surprisingly simple and quick operation. The lining lasts for several weeks,

very properly, a foundry pig-iron, this card having been chosen because it illustrates, with particular clarity, two distinct and typical phases:—

(*a*) *Pre-Specification.*—The inconstancy of the tabulated analyses indicates the need for definite specification of requirements, and

(*b*) *Post-Specification.*—The much greater degree of uniformity serves to emphasise the improvement obtainable when the requirements of the purchaser are clearly defined.

Begun in this fashion, technical control, continued by standardisation of successful manufacturing methods, ends with observation and systematic recording of procedure and results.

(*Concluded on page* 258.)

Alloy Cast Iron

By H. A. MacCOLL

(*Concluded from page 236.*)

Nicrosilal[54 55] and Ni-resist[56] may be considered together. The former emanated from the B.C.I.R.A., whilst the latter was first introduced in the U.S.A. under the name of Nimol. Both irons have a structure consisting of fine graphite in an austenitic matrix, induced by substantial additions of nickel. The nature of the matrix confers an important advantage on these irons as compared with Silal, namely, a considerable measure of ductility, and easy machining. Typical compositions are compared in Table XII. The austenitic cast irons are markedly superior to ordinary cast iron at elevated temperatures, and when used for this purpose it is beneficial to keep the chromium content as high as possible compatible with ease of machining. Nicrosilal offers a greater resistance to heat than Ni-resist, the latter having been developed, in the first instance, as a corrosion-resisting iron.

TABLE XII.—*Typical Compositions of Austenitic Cast Irons.*

	"Ni-resist."	"Nicrosilal."
T.C. Per cent. ..	2.44	1.75
Gr. Per cent. ..	1.7	1.47
Si. Per cent. ..	1.11	5.84
Mn. Per cent. ..	0.76	0.68
S. Per cent. ..	0.057	0.039
P. Per cent. ..	0.26	0.045
Ni. Per cent. ..	16.56	17.72
Cr. Per cent. ..	3.3	2.1
Cu. Per cent. ..	7.3	—

A Paper of great interest,[57] more particularly perhaps to the engineer, appeared in 1936, covering an investigation into the creep of five irons, which included Silal, Nicrosilal, Ni-resist, a nickel-chromium iron and a common grey iron. The investigation was directed to ascertaining, amongst other things, the suitability of the three special irons for high-temperature steam plant. The complete superiority of the special irons was demonstrated. Curiously enough, both Nicrosilal and Ni-resist proved better at high temperatures than at lower ones. Another interesting discovery was also made, namely, that the rates of creep and growth of the ordinary grey iron and the nickel-chrome iron were considerably reduced by a preliminary heat-treatment below the critical temperature.

TABLE XIII.—*General Properties of Austenitic Cast Irons compared with Cast Iron and Non-Ferrous Alloys.* (Hurst.)

	Austenitic cast iron.	Ordinary cast iron.	Brass.	Bronze.
Specific gravity	7.5—7.6	6.9—7.7	8.0—8.2	8.2—8.5
Specific heat	—	0.12	0.09	0.26
Thermal conductivity	0.08	0.11—0.13	0.26	0.26
Magnetic permeability (max.)	1.03	240.0	1.0	1.0
Specific resist. Microhms per cm.^{3}	150.0	95.0	7.0	16.0
Resistance temp. coeffic. 0—100 deg. C.	0.00045	0.0019	0.002	0.00065
Coeffic. of expansion	1.8×10^{-5}	1.1×10^{-5}	1.88—1.98×10^{-5}	1.8×10^{-5}
Tensile strength. Tons per sq. in.	15—25	12—20	20—40	20 app.
Elongation. Per cent.	1—3	Nil	20	8
Mod. of elasticity. Lbs./in.$^2\times10^{-6}$	14—21	14—18	11—14	11—14

Ni-resist, as mentioned above, was developed originally as a corrosion-resisting iron. It has a corrosion resistance equal, or even superior, to bronze under many conditions, whilst possessing better wear resistance. Table XIII, due to Hurst, compares the properties of austenitic iron with those of ordinary cast iron and the common non-ferrous alloys. It will be noted that the mechanical properties compare very favourably with brass and bronze. In common with other austenitic materials, Ni-resist has a tendency to work-harden, and this is particularly useful where the corrosion is accompanied by abrasion, as in the case of, say, the pumping of sewage. Ni-resist is finding increasing application in the chemical industry, and ample data are available for the use of engineers and others to enable them to select the most suitable composition for their requirements.

Inoculated Iron

At the beginning of this Paper, production of fine graphite was mentioned as likely to confer added strength on an iron. It has been seen that the majority of the alloy elements do assist in a certain measure in this direction, but so far no mention has been made of procedures having the production of fine graphite as their specific object. It has been found that marked graphite refinement may be accomplished by superheating an iron or by making a ladle addition of a graphitising agent to an iron which under normal conditions would solidify as a white iron. The latter process is termed "inoculation," and is mentioned because it is an integral part of the production of the special iron known as Ni-tensyl. Norbury and Morgan[58] have described the production of fine graphite by an addition of ferro-titanium followed by oxidation by bubbling carbon dioxide gas through the metal.

Ni-tensyl,[59] which in common with Silal, Nicrosilal, etc., is the subject of patents, has been sponsored by the Mond Nickel Company. Briefly, it consists of a high-strength matrix, accompanied by finely divided graphite. It has the great merit of admirable mechanical properties, combined with low cost, since the sole alloy addition consists of 1.5 per cent. nickel, which together with ferro-silicon is added in the ladle.

The mechanical properties may be described as startling when compared with normal high-duty and alloy cast irons, as 25 tons per sq. in. is a usual figure, and values up to 30 tons have been reported. Further, the iron is amenable to heat-treatment, in which case the 30-ton figure may be obtained with reasonable certainty every time. As to the figures quoted, it should be pointed out that adequate foundry practice is assumed. As an indication of the type of work which can be produced, the case of a crusher frame weighing 17 tons finished can be cited, wherein the tensile strength in the centre of a section 9 in. thick was 23 tons per sq. in. This iron is easily machined at Brinell hardnesses of 250 and over. It can obviously be employed for a wide variety of work, and may be used as a substitute for steel castings in many cases.

Ni-hard

The last of the special irons to be considered is again due to the Mond Nickel Company, namely, Ni-hard.[60] Ordinary white irons produced either as-cast or by chilling suffer from brittleness and lack of strength, and these defects have been mitigated in the iron to be described. The underlying principle is the retention of the massive carbides characteristic of a white iron, accompanied by a martensitic matrix instead of the pearlitic one found in white iron. At the same time, the alloy additions responsible for the martensite in the surface layers also refine the underlying grey core. The net result is a much higher hardness in the chill and vastly improved core strength. The importance of increased core strength will be apparent in such castings as rolls, where torque has to be transmitted. It will be appreciated that machining will not be easy, but this is not to be expected in the nature of things.

However, except where extreme hardness is required, machining may be carried out using Widia tools; in the limiting case, grinding is the only possible procedure. Ni-hard may be applied for all purposes where white irons have been used in the past, and service conditions have afforded ample confirmation of its superiority, as is stressed in Tables XIV and XV.

TABLE XIV.—*Typical Compositions of "Ni-Hard."* (*Bur. Inform. on Nickel.*)

	A.	B.	C.	D.
T. C. Per cent. ..	3.0	2.8	3.6	3.6
Si. Per cent. ..	0.8	0.5	0.8	0.5
Mn. Per cent. ..	1.2	1.2	0.8	0.8
S. Per cent. ..	0.1	0.1	0.1	0.1
P. Per cent. ..	0.3	0.3	0.3	0.3
Ni. Per cent. ..	4.5	4.5	4.5	4.5
Cr. Per cent. ..	1.0	0.75	1.5	1.5
Mo. Per cent. ..	—	0.25	—	0.25

Type A is for light-section chilled castings of maximum strength; B is for heavy castings of maximum strength; C is for light castings of maximum hardness; D is for heavy castings of maximum hardness.

The Production Angle

It remains to give some account of the production of alloy irons in the foundry. Straight away it can be stated categorically that success with alloy irons is dependent on ability to produce ordinary irons of the highest class. Alloy additions are not a medicine for poor foundry practice, and the dabbler is likely to burn his fingers.

If a customer be required to pay an enhanced price for an alloy iron casting, he demands, first and foremost, value for his money in the form of better service and better quality, which stresses the important point that there should be the closest co-operation between the customer and the founder. The former should be encouraged to give the fullest details of the job for which the casting is required, so that the founder may supply him with the most suitable material; in this way the customer will receive the full value of the alloy iron, whereas if information is withheld a perfectly good casting may be supplied which, through being of unsuitable composition, may be little superior to an ordinary straight engineering iron.

So far as the low alloy addition irons are concerned, 75 per cent. of the battle is the ability to produce a suitable base iron, which, taken in general, involves the production of an iron having a total carbon of 3 to 3.3 per cent.; silicon controlled accurately to suit requirements, generally about 1 to 1.5 per cent.; low phosphorus, and a manganese content of about 0.7 per cent. It is hardly necessary to point out that this will involve an accurate knowledge of the composition of all raw materials and irreproachable cupola practice.

Compounding the Alloys

The alloying elements may be introduced into the melt in a variety of ways. The commonest element, namely nickel, is available in several forms. The most popular of these is nickel "F" shot, which is a nickel-silicon alloy containing 92 per cent. of nickel, and has a melting point of about 1,260 deg. C., which renders its solution quite simple. The same material is available in ingot form, whilst pure nickel may

also be obtained as shot or ingot. The remaining choice is the use of pig-iron containing nickel.

Present-day practice in the choice and method of addition has been reported on by many authorities, the general concensus of opinion being as follows:—For small quantities of iron, the addition of "F" shot, introduced into the metal stream as close to the tap hole as convenient as the metal is tapped into the ladle. It is also recommended that the ladle is suspended from a spring balance during the operation to ensure the correct weight of iron being used to suit the addition.

For appreciable quantities of iron, the nickel should be introduced via the cupola, but opinions differ as to the form of the addition. One well-known authority avoids the use of any concentrated form such as ingots, and advises a nickel-bearing pig. If ingots are used there is a slight loss to 2 to 2½ per cent. The nickel iron should be charged first where possible, and the alloy added in the first part of the charge; additionally the amount of alloy iron should exceed requirements to avoid contamination. It will be realised that in the case of irons made in furnaces other than the cupola, the above problems do not arise, and the nickel may be added in any form, a short time prior to tapping.

Chromium Additions

Chromium is rather more difficult to add than nickel. It is available as ferro-chrome, as a chrome pig-iron, or as chromium briquettes. The solution of ferro-chrome is a matter of difficulty, and opinion appears to regard its use as a ladle addition as undesirable, although with care this method can be made to give satisfactory results where not more than 0.5 per cent. of chromium is required in the metal. The finely crushed ferro-chrome should be well rabbled into the metal or losses may be excessive. Under the best conditions the losses may be up to 15 per cent. of the amount added.

The best method undoubtedly is the use of a suitable chromium pig-iron, and this applies also where larger quantities of chromium are required. Hurst[61] has published some interesting figures in connection with chromium additions in various forms. Excessive loss was encountered when ferro-chrome was used in the cupola, and experiments using chrome pig-irons of varying chromium content showed that the smallest losses were obtained with an 8 per cent. chromium pig. It is emphasised, however, that variations may be expected under differing cupola conditions.

Adding Molybdenum, Vanadium and Copper

Additions of molybdenum may be made as ferro-molybdenum containing 55 to 65 per cent. metallic molybdenum. The crushed alloy may be added at the spout as in the case of nickel. It is recommended that no addition be made until a reasonable amount of metal is in the ladle, otherwise trouble may ensue due to the ferro-molybdenum sticking to the bottom. Molybdenum pig is not readily available, but an alternative for air-furnace or rotary-furnace work is calcium molybdate. If used, ample time must be allowed for solution—about two hours for safety.

There is little to say concerning vanadium. It may be added in the ladle as ferro-vanadium, or alternatively vanadium pig-irons are available. Losses must be taken into consideration in ladle additions.

In the case of copper, there is the advantage that scrap copper in any form may be used, either as a ladle addition, as part of the cupola charge or just prior to tapping in other types of furnace. The copper passes into solution easily, and the only precaution necessary is to stir the ladle well, as with fairly large additions there may be a tendency to segregation at the bottom of the ladle. Oxidation losses need not be considered.

Technique for Ni-Resist and Nicrosilal

Austenitic cast irons of the Ni-resist and Nicrosilal type may be made either in the cupola or the crucible furnace. In the production of Ni-resist, the charge is made up of a suitable base iron to which a Ni-Cu-Cr pig is added. Monel metal may also be used together with a chromium pig. Ladle additions should be avoided. Melting losses are experienced with the silicon and manganese, and in the case of crucible melting carbon also.

The foundry technique requires close attention, as the metal has little life and should be poured as hot and as quickly as possible. Feeder heads should be on the most generous lines, and it is recommended that the cross-sectional area of the feeders should exceed the heaviest section of the casting. The question of dry-sand or green-sand moulds for these irons is uncertain, as good results have been obtained with both. It is important to note that where chaplets are required, these should be of austenitic iron or Monel metal.

Table XV.—*Typical Results of Tests of Chilled Plain and "Ni-Hard" Irons.*

	Unalloyed iron.		"Ni-Hard."	
	High carbon.	Low carbon.	High carbon.	Low carbon.
T.C. Per cent.	3.50	2.75	3.50	2.75
Si. Per cent.	0.75	0.75	0.75	0.75
Ni. Per cent...	—	—	4.50	4.50
Cr. Per cent.	—	—	1.50	1.50
Brinell hardness of chilled surface	500	400	650—700	575
Shore hardness on chill face	70	55	90	78
Tensile strength in chilled section. Tons/sq. in.	16—18	21—24	25—27	31—36
Tensile strength in grey core. Tons/sq. in.	7—11	10—17.5	13—16	18—22

Handling Ni-tensyl

Ni-tensyl is usually produced in the cupola. The base iron recommended is a low total-carbon iron of 2.5 to 3 per cent.; silicon, 0.5 to 0.8 per cent., and in particular low phosphorus—0.2 per cent. maximum. The charge may consist almost entirely of steel, avoiding too light material. In the rotary furnace the charge must consist of refined pig-iron in the main, in order to obtain the required carbon. Inoculation should be carried out in the ladle or the bath just prior to pouring. The metal is comparatively "dead" due to possessing a short freezing range, and should be poured as soon after inoculation as practicable. Runners, etc., should be on the same generous lines as in the case of the austenitic irons. As regards the moulding, steel-foundry technique is advised, as the contraction is strong and tearing may occur. For the same reason the castings should be released as soon as possible, and core grids, etc., removed or broken.

With regard to Ni-hard, the introduction of the alloy additions and the foundry technique follow the practice outlined for low alloy additions and normal white-iron practice.

Conclusion

Sufficient has been said in the space available to indicate the salient features of alloy irons and their production. It must not be thought for one moment that alloy cast irons are to be regarded as rendering all other irons obsolete; far from it. Normal grey cast iron will always satisfy a very large percentage of all ordinary requirements. Likewise, it is not claimed that high strength is not obtainable by other methods, but it is claimed that alloy irons possess decided advantages as regards uniformity of structure in differing sections, coupled with greater freedom from porosity, *i.e.*, a finer all-round grain. The special irons are a different proposition, and cannot be duplicated by alternative methods of manufacture.

For a Paper of this description, it is necessary to quote extensively from the work of many investigators, and the author would like to offer his debt to the many gentlemen whose Papers have been abstracted. Acknowledgment is also due to the Copper Development Association, the Climax Molybdenum Corporation and the American Vanadium Corporation, whose publications have been freely abstracted in their respective sections. Valuable assistance has been given to the author by the Bureau of Information on Nickel in connection with the special irons, and for the loan of lantern slides. Slides have also been made by Mr. Forrest, and the authorities of the Bradford Technical College.

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DISCUSSION

The President (Mr. A. S. Worcester) said that Mr. MacColl had obviously gone to a great deal of trouble to frame the Paper in such a way that it brought down alloy irons to their common uses, described in a manner the average foundryman might reasonably understand.

Mr. W. G. Thornton (Bradford—Past-President) asked whether it was possible to produce a test bar purely from pearlite. He had been rather surprised the lecturer had not mentioned anything as to the wearing qualities of iron containing molybdenum, and any information on that point would be appreciated.

Mr. MacColl said it was obviously impossible to produce a pearlitic test bar free from graphite. In regard to the wearing resistance of molybdenum, it did impart certain important properties in that direction. There was a good deal of technical information on that matter available.

Wearing Properties

Mr. A. W. Walker (Huddersfield—Past-President) said that whilst the speaker's review of what could be done with these alloys was extremely interesting and informative in regard to special work, it had to be remembered that the facilities for using these irons as they should be used hardly existed in the average everyday foundry. Commenting on methods of application of the alloys, Mr. Walker felt one could not be sure of getting a positive value by adding at the spout. In regard to the observations on wearing properties of a cast iron, it must be kept in mind that Brinell hardness was not a sure guide as to wearing property. He was unaware that the addition of nickel necessarily increased heat resistance of any iron, though with the addition of chromium it might have some such effect. Whilst Mr. MacColl had given some valuable and useful data, yet the average foundryman must not expect to become an alloy expert merely because he was adding something at the spout. Further information as to estimating molybdenum would be welcome.

Mr. MacColl replied that there were acknowledged experts who refused to agree that one could add alloys successfully at the ladle. On the other hand, the general consensus of opinion inclined to the idea that it could be done. It was not claimed that nickel in small

quantity induced heat resistance, but did so when the iron became austenitic. Chromium did, of course, induce heat resistance.

Function of Graphite

MR. H. FORREST (Bradford—Past-President), speaking on the spout addition of alloys, said his personal experience of adding nickel at the spout was that the nickel content analysed out as calculated, but the addition must be made with care. The nickel should not be dumped into the metal stream as it comes from the tap hole, but should be added carefully whilst the ladle was filling. In regard to the addition of molybdenum, Mr. Forrest said it was as well to remember that this alloy was very powdery, and there was the possibility that if added at the spout a certain amount of it might be carried away. On the point as to wearing qualities, it seemed to him that this was not a matter they could ascribe to any particular element or any particular addition. The addition of alloys must be regulated to suit various types of metal structure. The formation of graphite had a very big bearing, and the absence of ferrite was essential. In reference to estimating molybdenum, as raised by Mr. Walker, Mr. Forrest said a method had been worked out by two members of the West Yorkshire Branch of the Institute, which had been adopted by the British Cast Iron Research Association and by a number of leading analysts, and in his (Mr. Forrest's) opinion it gave a better approximation of estimating molybdenum than anything else he knew.

MR. WALKER said he was, of course, glad to realise that members of the Branch were contributing to the development of the industry in the way mentioned by Mr. Forrest, but for ordinary foundry practice purposes it was as well to remember that the average foundryman had not quite the same sense of detailed care as an analyst in adding to the ladle.

The PRESIDENT (Mr. Worcester) said it was quite true, and important to remember, that the addition of "a handful of dope" in the form of alloys, must not be expected to be a cure-all for general foundry problems. The basis of alloy additions was that it must not be done with low carbon irons, or trouble would result.

Closing the discussion, the CHAIRMAN said he felt Mr. MacColl's Paper would be regarded as a really concise collation of alloy data.

Vote of Thanks

MR. S. W. WISE (Bradford, Hon. Secretary), proposing a vote of thanks to Mr. MacColl, said Mr. MacColl had condensed a mass of facts to an almost unbelievable extent to get his subject into one Paper.

MR. W. RILEY (Harrogate) seconded.

MR. MACCOLL, in response, said one of the greatest values of preparing a Paper for submission to a technical audience was the extent to which one's own knowledge was widened by the research involved. The preparation of a Paper brought its own reward in that way, but he was grateful also for the observations made by members during the discussion.

Whitehead Steel Company's Expansion

Progress made by the Whitehead Iron & Steel Company, Limited, during the past 12 months was outlined by the chairman of the company, Mr. G. H. Latham, at a gathering at Newport on Friday last. The cold-rolling department was making excellent headway. At the Cwmbran works they had embarked upon a major scheme of modernising the whole plant, and at the Cwmbran brickworks they had doubled the output by the end of 1938, though the demand still exceeded the supply. Another enterprise they had recently embarked upon was the acquisition of a controlling interest in the firm of foundrymen and craftsmen, W. A. Baker & Company, Limited, Newport. As a result of that they would be able to develop the foundry, and a new engineering works, which would not only provide employment for the 150 or 200 men at W. A. Baker's works, but a great many more Newport men as well later on.

The Copper Situation

BY "ONLOOKER."

A good deal of the recent strength displayed by the non-ferrous metal group in London has been due to the lead given by copper, which staged an advance on the standard market of fully £2 per ton. To account for this is not easy since demand in Europe, although reasonably good, is adequately matched by production, and there does not seem to be the slightest possibility of any squeeze for nearby supplies. Most of the reasons for the rise in copper values can probably be ascribed to the fact that the American producers have held their price at 11¼ cents, even though they have not been able to dispose of much metal, apart from what has gone into consumption with their own affiliated fabricating plants. As soon as other selling interests realised that the London market was showing a firmer front, the initial advance from £41 10s. taking place mainly because buyers on 'Change found the position to be rather sold out, there was a move up in the "outside" offers on the domestic market in America. This fact naturally had its effect on London, and, with the upward movement developing there, it was not long before the "outsiders" in the States were holding for 11 cents, which was only 25 points below the official price.

Then came a sequence of disturbing events in Central Europe, as a result of which confidence received a very rude shock and business enterprise temporarily dried up almost completely. Wall Street began a series of bad days, and this weakness on the New York stock market had an immediate effect on the London copper market, which lost ground rapidly. There was without doubt a modest bull account open in standard, but at the first hint of trouble holders began to get out while they could still see a profit, and with buyers showing reserve it was inevitable that a downward movement should result. The February statistics were very much as expected, but with production outside the U.S. down to 95 per cent. there is every reason to suppose that the statistical position will improve as the months go by. Not that there is really anything amiss, for the position is roughly in equilibrium, and stocks above ground are certainly not excessive as a background for the present rate of consumption, which at 150,000 short tons per month for the world is certainly quite good. Control of production is, of course, a two-edged weapon, for while it certainly does serve to keep the price at a proper level it also tends to stifle initiative on the futures market, where operators are inclined to restrict their ventures within very sober limits. Control by a cartel certainly does not stimulate speculation, and without that one cannot expect very exciting price movements in any commodity.

An interesting development in the copper situation in this country is the movement towards self sufficiency in refining, and there is even talk of an electrolytic plant being erected. It is perfectly true that we have at present moderately large stocks of rough copper lying in warehouses in the U.K., but it is very difficult to see how an electrolytic refinery could be a paying proposition in Britain, and once production was under way it would not take long to run through our present reserves of rough copper. Incidentally this tonnage acts as the basis for trading in standard copper, and were it converted into refined we should find the margin between standard and electro narrowing considerably. It may be that this scheme has the blessing of the Government, and would even be accorded financial support, but a cheaper method to ensure adequate supplies of electrolytic copper would surely be to lay in a war stock of, say, 50,000 tons, which at ruling prices might well turn out to be a good investment. In any case, the old argument of the freedom of the seas still obtains, and Canada could keep this country supplied.

Publications Received

Index to the Literature on Spectrochemical Analysis. 1920-1937. Compiled by William F. Meggers and Bourdon F. Scribner. Published by American Society for Testing Materials, 260, South Broad Street, Philadelphia, Pa. Price $1.

Based on work which has continued over many years in the Spectroscopy Section of the National Bureau of Standards in Washington, this publication contains a listing of over 900 references on chemical analysis by means of atomic emission spectra. While various reviews in the past have given references to particular applications, this is the first general comprehensive index to spectrochemical literature. It should be of much significance to those concerned with this field. All items are arranged in chronological order, with titles given in English (book titles have not been translated, however). References to published abstracts are given. Of particular interest is the detailed index, which indicates most, if not all, of the literature pertaining to a particular application, determination, instrument, method or similar topic. Each reference is numbered, these numbers being used in the index.

Structural Steel Work—Tables and Data. Pocket Edition. Issued by Redpath, Brown & Company, Limited, 2, St. Andrew Square, Edinburgh.

This useful pocket book has been based on Redpath, Brown's handbook "Structural Steelwork, 1938," and relates to British standard sections as revised in 1932. Properties and safe loads are given for joists and joist compounds as beams and as stanchions, filler joist floors, solid round columns, slab bases and grillages. Other tables relate to rivets and bolts, weights of sections and materials, mathematical tables and conversion equivalents. It should be stressed that this is really intended for the pocket, and to be used by men actually on the job and away from the office.

Melting Practice in a Large Engineering Iron Foundry

(*Concluded from page* 255.)

Fig. 11 shows the log in which all matters relating to furnace charges are detailed. This is also a materials stock sheet, and sets out every aspect of the position with regard to each furnace requisite. The accounts of a typical week are inserted for the purpose of illustration, and the arrangement is probably self-explanatory.

All chemical analyses, physical test results, and relevant observations are set down in the "Metallurgical Record," which also is shown in a typically completed form (Fig. 12).

These records have proved of immeasurable value to the metallurgical section of this foundry, retaining, as they do, in singularly concise form, complete accounts of all experiences, the results of routine practice or of special procedure being preserved with equal certainty. By this means, details of successful procedure, often costly to develop, are accurately recorded, and are subsequently available to ensure safe handling of a recurring situation, or to assist in the solution of a new problem.

Acknowledgment

Thanks are due to the Directors of Babcock & Wilcox, Limited, and to Mr. W. H. Birks, M.I.Mech.E., Manager of the Renfrew Works, for permission to present this Paper.

The author is also deeply indebted to Mr. Hector G. Paton, his colleague and friend, whose drawings have so enhanced the value of this Paper, and to all of those associates who have in any way assisted in its preparation.

Finally, the author desires publicly to express his gratitude to Mr. Robert O. Patterson, Superintendent of the Renfrew Foundries, whose kindly interest, constructive criticism, and unfailing support are a constant encouragement.

Of interest to Pig Iron Users

THE STANTON METALLURGICAL SERVICE

The Stanton Company believe that a mutual policy of collaboration in more scientific and better methods of manufacture, can do much to widen the field for cast-iron products.

The Stanton Company therefore offer to all those engaged in the Iron Foundry Trades the free advisory service of specialists in metallurgical practice and technique.

This service takes the form of analyses and tests by the Company's Research Department on castings submitted to them, and constructive suggestions if the desired results are not being attained.

Where there are difficulties in works practice which can best be investigated on the spot, the service provides for a personal visit from a Stanton metallurgical expert, who will collaborate with the foundry staff.

THE STANTON IRONWORKS COMPANY LIMITED
Near NOTTINGHAM

The Largest Producers of Foundry Pig Iron (for Sale) in Great Britain

The Week's News in Brief

Trade Talk

ALLAN URE & COMPANY, LIMITED, range and grate makers, of Keppochhill, Glasgow, are carrying out extensions to their works.

VICKERS-ARMSTRONG, LIMITED, have secured an order from the Turkish Government for four submarines, which will be built at Barrow-in-Furness.

THE HILLSIDE FOUNDRY, at Cupar, Fife, has been taken over by Mr. Robert Tulloch, of Dundee, and Mr. Sydney Plenderleath has been appointed to manage the concern.

AWARDS FOR long service have been made to 26 employees of Ley's Malleable Castings Company, Limited, and Ewart Chainbelt Company, Limited, Derby. Mr. Francis Ley, the general manager, made the presentation.

MIDDLESBROUGH TOWN COUNCIL is applying to the Ministry of Health for sanction to borrow £20,665 for the laying of five miles of gas main from the Grangetown works of Dorman, Long & Company, Limited, to Middlesbrough, in connection with a coke-oven gas supply.

OUGRÉE STEEL TRADING COMPANY, LIMITED, Stone House, Bishopsgate, London, E.C.2, have taken over from Chilled Castings, Limited, of 27, Mincing Lane, London, E.C.3, the representation of Société Belge Griffin, S.A., of Antwerp, manufacturers of chilled cast wheels, rollers, crushers and chilled castings of all types.

THE MEETING in London last Thursday of the Southern Section of the Institute of Vitreous Enamellers was devoted to a cinematographic display (under the charge of Mr. B. B. Kent), which dealt with the official visit paid to America last autumn by members of the Institute. The pictures, some of which were in colour, included a number taken on board the "Georgic," in which the party, numbering fourteen, travelled to New York.

THE NEW electric power plant for Glasgow, which is to cost about £2,000,000, will, it is reported, be erected at Shieldhall. It will be erected by Glasgow Corporation in conjunction with the Electricity Commissioners and the Government. Another new activity in the Shieldhall area will be the production of electric lamps, the S.C.W.S. being engaged on the erection of a factory for that purpose.

PRODUCTION OF COMMERCIAL STEEL CASTINGS in the United States, as reported by the Bureau of Census, was 342,737 net tons in 1938, as compared with 1,019,896 tons in 1937 and 805,691 tons in 1936. Percentages of capacity operations for the three years respectively were 25.5 per cent., 71.3 per cent., and 56.3 per cent. Booked orders totalled 333,278 tons in 1938, as against 877,459 tons in 1937 and 909,080 tons in 1936.

THE SITE at Cwmbran, South Wales, where the Saunders Valve Company's new factory was opened on Wednesday, March 15, was one of those developed on behalf of the Commissioner for the Special Areas by South Wales and Monmouthshire Trading Estates, Limited, the company also responsible for the Treforest Trading Estate, where there are now 34 factories in production and as many more in preparation. An article describing the works appears elsewhere in this issue.

THE HEAD OFFICE and London works of Keith Blackman, Limited, are now at Mill Mead Road, Tottenham, London, N.17. The telephone number is Tottenham 4522 and the telegraphic address "Keithblac Phone London." The new offices and works have been erected on a 10½-acre site in close proximity to Tottenham Hale L.N.E.R. Station. New manufacturing plant of the latest design has been installed, and this, in conjunction with the vastly increased production facilities afforded by the new works, will enable the firm to cope more successfully with the increasing demand for their specialties.

MR. ERNEST BROWN'S Unemployment Insurance Bill, which has been introduced into the House of Commons, contains provisions designed to give effect to the recommendations of the Unemployment Insurance Statutory Committee in their report of October 7 last on holidays and suspensions in relation to unemployment insurance. The Bill lays down the principle that a person who is on holiday shall not be entitled to receive unemployment benefit for the holiday or to count it as a period of unemployment. It enables regulations to be made for the purpose of deciding when a person is on holiday and whether unemployment insurance, national health and old age contributory pensions contributions are payable in respect of weeks of holiday for which payment is received by an employed person. Another provision of the Bill is that the receipt of payments from an employer after suspension or termination of employment shall not be a bar to the receipt of unemployment benefit provided that the payments are made under arrangements approved by the Minister.

THE ANNUAL works dinner of Qualcast, Limited, at the Drill Hall, Derby, last Saturday, was attended by nearly 800 employees. Mr. V. Jobson (managing director) said that despite the setback of the crisis the firm was going ahead, and he thought the year would finish as it usually did—a record one in output, wages and profits. He reminded his audience that, with the associated company of Follows & Bate, Limited, of Manchester, the group was the largest manufacturer of lawn-mowers in the world, the output being about 300,000 a year. Mr. Jobson described the steps being taken to safeguard the employees in the event of air raids, and said it was aimed to evacuate the works and have everybody protected within three minutes. Mr. C. W. Bigg (assistant managing director) expressed his pleasure that so many of those present at this, the nineteenth annual works dinner, should also have been at the first. It could be interpreted as evidence that employees joining the firm stayed with it, and that customers and friends who visited them seldom broke off their association with it. Mr. F. S. Richardson (sales manager) and Mr. W. H. Barnes (managing director of Follows & Bate) also spoke, and during the evening Mr. Jobson made presentations to several employees (including the secretary of the company, Mr. F. J. A. Toft) for long service. Mr. W. Glover and Mr. Hendley, with 41 and 40 years' service respectively, received gold watches.

Personal

MR. GEORGE PATE, O.B.E., manager of the Carron Company, Falkirk, has become a member of the Scottish Committee of the Council for Art and Industry.

MR. JOHN H. BENTLEY has been appointed a technical director of Ernest Newell & Company, Limited, engineers, of Misterton, Doncaster. Mr. Bentley has been with the firm for over 30 years as chief engineer.

MR. J. E. MONTGOMERY, B.Sc.(Eng.), M.I.Mech.E., has been appointed as Secretary of the Institution of Mechanical Engineers, in succession to Brigadier-General Magnus Mowat, C.B.E., who has retired on account of ill-health. Mr. Montgomery was assistant secretary of the Institution since 1920.

MR. GEOFFREY SUMMERS, who has been appointed the new High Sheriff of Flintshire, is the son of Mr. H. H. Summers, chairman of John Summers & Sons, Limited, of Shotton, in the management of which he takes a leading part. Mr. J. Summers is chairman of two wages conciliation boards in the iron and steel industry—the Sheet Trade Board and the Galvanising Board—vice-chairman of the British Steelwork Association, and chairman of the Association's Steel Market Development Committee.

Wills

RUDGE, W. H., Great Sankey, Lancashire, retired company director, late of Fletcher, Russell & Company, Limited, ironfounders £28,785

BLACKADDER, THOMAS, partner in Blackadder Bros., engineers and founders, of Falkirk, who died at Nice, France £12,951

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Joseph Westwood & Sons (Cradley Heath), Limited, Compton Road, Cradley Heath, Staffs.—Capital, £25,000. Chainmakers, iron, steel and brass founders, etc. Directors: J. Westwood and Mrs. E. Westwood.

Obituary

MR. HARVEY DENTON, a director of Denton Bros. (Sheffield), Limited, Soho Steelworks, Sheffield, has died after a short illness.

SIR LOUIS WILLIAM SMITH, M.P. for the Hallam Division of Sheffield, died on March 15, at his London home. He was 60 years of age. Sir Louis was born at Grimsby, and was trained for the engineering profession at Lincoln. Subsequently he spent two years with a Berlin firm of machine tool manufacturers, and gained managerial experience in Birmingham and Ipswich. In 1909 he became chairman of Clark's Crank & Forge Company, Limited, forge masters, Lincoln, and he held this office for the remainder of his career. His other business activities included the chairmanship of Ambrose Shardlow & Company, Limited, engineers and drop-forgers, Sheffield, and Farrar Boilerworks, Limited, Newark-on-Trent. He was a member of the Grand Council of the Federation of British Industries. He was knighted in 1938.

Contracts Open

Newcastle-under-Lyme, March 31.—Castings for the year ending March 31, 1940, for the Borough Council. The Borough Surveyor, Municipal Offices, Nelson Place, Newcastle, Staffs.

Porthcawl, March 27.—Castings for 12 months from April 1, 1939, for the Urban District Council. The Engineer, Council Offices, Porthcawl.

Southwell, April 4.—Provision and laying of 252 yds. of 3 in. cast-iron pipe water main (Class "C" spun pipes), for the Southwell Rural District Council. Mr. S. Cooper, surveyor, 8, Westgate, Southwell, Notts.

Tipton.—Cast-iron gulley grates, manhole covers, frames, etc., for twelve months, for the Borough Council. Mr. K. W. Madin, town clerk, Tipton, Staffs.

Fish-Scaling in Ground-Coat Enamel

J. KLÄRDING, in "Stahl und Eisen," describes various forms of fish-scales in ground-coat enamel, and shows that the adequate fluidity and gas porosity of the enamel at the firing temperature are of greater importance for the avoidance of fish-scales than the strength of the enamel.

Forthcoming Events

MARCH 24.

Keighley Association of Engineers:—Annual dinner, at Victoria Hotel, Keighley, at 6.45 p.m.

Manchester Association of Engineers:—Annual general meeting; "Air Compressors," Paper by S. N. Howe, at Engineers' Club, Manchester, at 7 p.m.

MARCH 29.

Institute of Welding (South Wales Branch):—"Repairing Castings and Reclaiming Worn Parts by Oxy-Acetylene Welding," Paper by E. Ryalls, at Newport Technical College, Newport, at 7 p.m.

MARCH 30.

Institute of Metals (Birmingham Section):—"Some Observations on the Freezing of Cast Iron," Paper by J. E. Hurst, at James Watt Memorial Institute, Great Charles Street, Birmingham, at 7 p.m.

Institute of Metals (London Section):—Annual general meeting and open discussion, "Impressions of America, 1938," at Society of Motor Manufacturers and Traders, Hobart House, Wilton Street, London, S.W.1, at 7.30 p.m.

Institute of Welding (Leeds and District Branch):—Annual dinner, at Griffin Hotel, Leeds.

Institute of British Foundrymen

MARCH 25.

East Midlands Branch:—Annual general meeting; Short Paper competition, at Loughborough College, at 6 p.m.

Lancashire Branch (Junior Section):—Annual social and dance, at Manchester, Limited, Café, Cross Street, Manchester, at 6.30 p.m.

Newcastle-upon-Tyne and District Branch:—Paper by T. B. Burrows; annual general meeting, at Neville Hall, Newcastle-upon-Tyne, at 6.15 p.m.

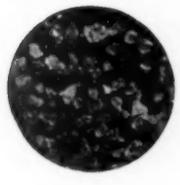
APRIL 1.

Lancashire Branch:—Annual general meeting; "Some Experiments Referring to Porosity in Cast Iron," Paper by W. West and C. C. Hodgson, at Engineers' Club, Manchester, at 3.30 p.m.

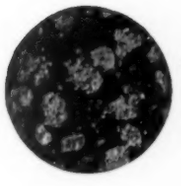
West Riding of Yorkshire Branch:—Works visit to Leyland Motors, Limited, Leyland.

Moulding Sands

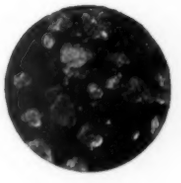
YORKSHIRE
Moulding Sand



THANET
Moulding Sand



YORK YELLOW
Moulding Sand



ZENITH
Moulding Sand

MANSFIELD
Moulding Sand

FROM unlimited resources we are able to supply Moulding Sands of various grades to meet all requirements. The photo-micrographs (magnified 25 diameters) on the right show five of the large variety of sands which we produce. Our Technical Staff is at your service and will be pleased to make recommendations and to assist you in the selection of the most suitable sand to meet your exact needs.

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Raw Material Markets

Firms engaged on work in connection with the rearmament programme continue to be very active and are taking up substantial tonnages of special iron. Unfortunately, business in ordinary grades of foundry iron is still dull and many foundries are working short time. The steel market continues to increase in strength.

Pig-Iron

MIDDLESBROUGH.—Production of Cleveland foundry iron is not likely to be expanded for some time to come, as consumers continue to buy on a hand-to-mouth basis. Makers are avoiding the building up of unnecessarily high stocks and are maintaining a close watch on the position of supplies. It is suggested in some quarters that part of the reason for the lack of orders is the fact that producers may lower existing quotations at an early date, but in official circles this possibility is discounted. For delivery to Middlesbrough and Falkirk, No. 3 Cleveland G.M.B. foundry iron is quoted at 99s. per ton, No. 1 foundry iron 102s., and No. 4 foundry and No. 4 forge iron, 98s. The demand from the Falkirk district continues to be at a very low ebb.

With the heavy engineering concerns working at a high rate of activity, the demand for hematite continues to expand, while the steelworks are also taking supplies satisfactorily. Makers generally have quite substantial stocks on hand, but existing contracts are being worked off steadily, while quite a considerable amount of new business is being done. In some cases, consumers have booked tonnages for delivery during the second quarter of the year. Export trade remains lifeless. For delivery on the North-East Coast, East Coast hematite mixed numbers are quoted at 120s., 125s. 6d. in Sheffield, and 131s. in the Midlands.

LANCASHIRE.—Business in this area is still on the quiet side and current transactions involve only small tonnages for early delivery. Most of the local foundries are in need of further orders before they can work full time, but it does not appear likely that there will be any material improvement in the near future. Consumers of foundry iron are still making extensive use of scrap and this naturally affects the consumption of the former. The demand for hematite is increasing, but the existing rate of production is adequate to meet all requirements.

MIDLANDS.—A dull tone continues to rule in the market for high-phosphorus iron. Unless there is a pronounced increase in the rate of activity among the light-castings foundries, improvement in this section of the trade will be slow. The light-castings industry is closely linked up with the building trade and there was a very welcome increase in the value of building plans approved during last month. The Ministry of Labour reports that compared with January plans were higher to the extent of 37.6 per cent. in February, largely as a result of an expansion in housing plans. On the other hand, business in low-phosphorus iron continues to expand and this section of the market is quite satisfactory. Many of the consuming works are engaged on Government orders and are expected to remain busy over a considerable period. Hematite, too, is being taken up on a better scale and orders for this iron have shown a marked rise since the beginning of the year.

SCOTLAND.—Forward business in foundry iron is very scarce and, apart from a few orders for prompt deliveries, the market is quiet. Production is restricted to four blast furnaces making foundry iron, while a similar number is engaged on the production of hematite. Scrap is being used quite extensively by the light-castings founders, who continue to be badly situated for work. No. 3 foundry iron is quoted at 105s. 6d., with No. 1 at 108s., both f.o.t. furnaces. Steelworks in this area are well employed, but they are mostly well covered ahead for their requirements of pig-iron.

Coke

Coke ovens continue to receive a satisfactory demand for foundry coke and many consumers have covered their future needs over quite a long period. Makers quote 50s. 6d. as a minimum figure for both Durham and Welsh coke, delivered Birmingham and Black Country stations.

Steel

Nearly all sections of the steel market are well occupied. The demand for sheets for the production of air-raid shelters continues to provide a large amount of work for that section of the market, while other firms engaged on Government orders are being kept busy. A feature of the trade which gives rise to considerable satisfaction is the expansion in the call for structural material, makers of which are working at a much improved level. Producers of steel for shipbuilders continue to be quiet.

Scrap

There is a keen demand for all grades of scrap and merchants are having difficulty in meeting the requirements of all consumers. Generally speaking, there is no shortage of supplies, but the position is being carefully watched and the question of importing additional scrap may be seriously considered. In many cases, the ironfoundries are making use of scrap in place of pig-iron, owing to the more economical price of the former.

Metals

Although there was no suggestion of any panic measures on the London Metal Exchange as a result of the absorption of Czecho-Slovakia by the German Reich, the confidence of buyers was naturally weakened to some extent. The Prime Minister's speech at Birmingham on Friday, in which he strongly condemned the action of Germany and suggested that Britain would seek to participate in a peace *bloc*, had a good effect on the commodity markets generally. Business will continue to be quiet while the tension in Europe remains so acute.

Copper.—There has not been very much in the way of new business of late, and consumers prefer to satisfy their requirements as they arise rather than enter into long-term contracts. Friction in the international field, of course, has tended to keep trade at a low level, and it does not seem likely that there will be any revival of large-scale business until this has been considerably reduced.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £42 12s. 6d. to £42 13s. 9d.; Friday, £42 7s. 6d. to £42 10s.; Monday, £42 12s. 6d. to £42 15s.; Tuesday, £43 1s. 3d. to £43 3s. 9d.; Wednesday, £42 18s. 9d. to £43.

Three Months.—Thursday, £42 16s. 3d. to £42 18s. 9d.; Friday, £42 13s. 9d. to £42 15s.; Monday, £42 18s. 9d. to £43; Tuesday, £43 7s. 6d. to £43 8s. 9d.; Wednesday, £43 3s. 9d. to £43 5s.

Tin.—There has been an uncertain tone in this market during the past week. Consumers continue to remain aloof as far as new buying is concerned, and only small tonnages are changing hands. There has naturally been a considerable amount of discussion in tin circles as to what the International Tin Committee would do at their meeting which was held yesterday (Wednesday). About the only point on which all opinions agreed was that whatever decisions the Committee made, they would be of little immediate assistance to producers. It was suggested in many quarters that the Committee would reduce the existing production quota of 45 per cent. to about 40 per cent. Up to a late hour last night no news of the Committee's intentions had been received.

Official quotations were as follow :—

Cash.—Thursday, £215 to £215 5s.; Friday, £213 10s. to £213 15s.; Monday, £214 15s. to £215; Tuesday, £215 10s. to £216; Wednesday, £214 5s. to £214 15s.

Three Months.—Thursday, £214 7s. 6d. to £214 10s.; Friday, £213 to £213 5s.; Monday, £213 15s. to £214 5s.; Tuesday, £214 10s. to £214 15s.; Wednesday, £213 10s. to £214.

Spelter.—Galvanisers have continued to take up supplies on a satisfactory scale as a result of the orders from the Government in connection with air-raid precaution work. On the whole, however, trade in this metal is still disappointing.

Daily market prices :—

Ordinary.—Thursday, £13 12s. 6d.; Friday, £13 11s. 3d.; Monday, £13 12s. 6d.; Tuesday, £13 17s. 6d.; Wednesday, £13 13s. 9d.

Lead.—There was rather more activity in this market at the beginning of the week, but international tension helped to bring about a duller tone. On the whole, demand is on a satisfactory scale while consumption is inclined to expand slightly. A statement issued on Monday by the Lead Producers' Association says that the figures for the first six months' working of the Association were reviewed at a meeting on that day. It adds that there has been an improvement in the statistical position and stocks have been reduced by approximately 10,000 tons.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 12s. 6d.; Friday, £14 12s. 6d.; Monday, £14 12s. 6d.; Tuesday, £14 18s. 9d.; Wednesday, £14 17s. 6d.

Scrap.—Quite a good turnover is reported in this market during the past week or two, and the outlook is rather better than it was a short time ago, when business was exceedingly quiet.

Approximate selling prices for old metal :—New aluminium cuttings, £70; rolled, £55 to £57; cast, £32 to £33; foil, £80. Copper, £38 to £43; braziery, £36. Brass (clean), £20 to £24. Zinc, £10. Lead, £13 10s. Gunmetal, £38 to £39.

Company Reports

Blythe Colour Works, Limited.—Net profit, £30,154; final dividend of 12½ per cent., making 17½ per cent.

John Baker & Bessemer, Limited.—Profit for 1938, £49,087; dividend of 10 per cent. on the ordinary shares.

British Aluminium Company, Limited.—Profit for 1938, after placing £50,000 to depreciation reserve and £100,000 to reserve, £507,669; brought in, £101,423; final ordinary dividend of 8½ per cent., making 12½ per cent.; carried forward, £144,093.

Thos. Firth & John Brown, Limited.—Net profit for 1938, after charging debenture and mortgage interest, depreciation, income-tax and N.D.C., £515,056; final dividend of 11½ per cent., making 17½ per cent., free of tax, on the ordinary shares.

Barton & Sons, Limited.—Net profit, after making provision for tax, for the 14 months to December 31, £53,139; brought in, £321; to reserve, £6,250; interim dividends of 4 per cent. and 2 per cent., £22,500; final dividend of 2 per cent., £8,100; carried forward, £16,610.

C. Akrill & Company, Limited.—Profit for 1938, less preference dividend for year, £7,563; brought in, £20,532; dividend on the ordinary shares of 2s. per share, free of tax, £4,375; employees' benevolent and superannuation fund, £250; special development reserve, £2,389; carried forward, £21,081.

Midland Electric Manufacturing Company, Limited.—Net profit for year ended December 31, £52,386; brought in, £30,601; preference dividend, £4,078; dividend of 10 per cent. on the ordinary shares, £10,875; bonus of 15 per cent., £16,312; to general reserve, £20,000; carried forward, £31,721.

G. D. Peters & Company, Limited.—Net profit for 1938, £102,767; profit on the sale of investment in a subsidiary, £11,000; brought in, £4,392; final dividend of 15 per cent., making 25 per cent.; to general reserve, £71,250; new capital issue expenses written off, £1,360; taxation, £8,500; staff pensions, £5,000; carried forward, £13,698.

Delta Metal Company, Limited.—Trading profit for 1938, £211,392; dividends from subsidiary companies, etc., £19,280; tax and N.D.C., £90,000; depreciation, £20,455; net profit, £110,275; brought in, £19,353; dividend of 12½ per cent. and a bonus of 17½ per cent., both tax free, £90,000; written off premises, etc., £20,000; carried forward, £19,628.

Clarke, Chapman & Company, Limited.—Net profit for 1938, including dividends on investments, and after providing for all charges, repairs and upkeep of plant, and taxation, £96,841; depreciation, £14,463; brought in, £19,890; preference dividend, £4,889; dividend of 10 per cent. on the ordinary shares, £45,656; to reserve, £21,480; carried forward, £27,934.

William Beardmore & Company, Limited.—Dividend of 3½ per cent. on the ordinary stock for the period ended December 31, equivalent to a rate of approximately 7¾ per cent. per annum, less tax. The ordinary stock was issued in accordance with the scheme of arrangement sanctioned last July and ranks for dividend from July 20, 1938. Net profit for the year ended December 31 was £296,365; directors recommend that £160,000 be placed to a preference stock dividend reserve, and that a balance of approximately £95,000 be carried forward.